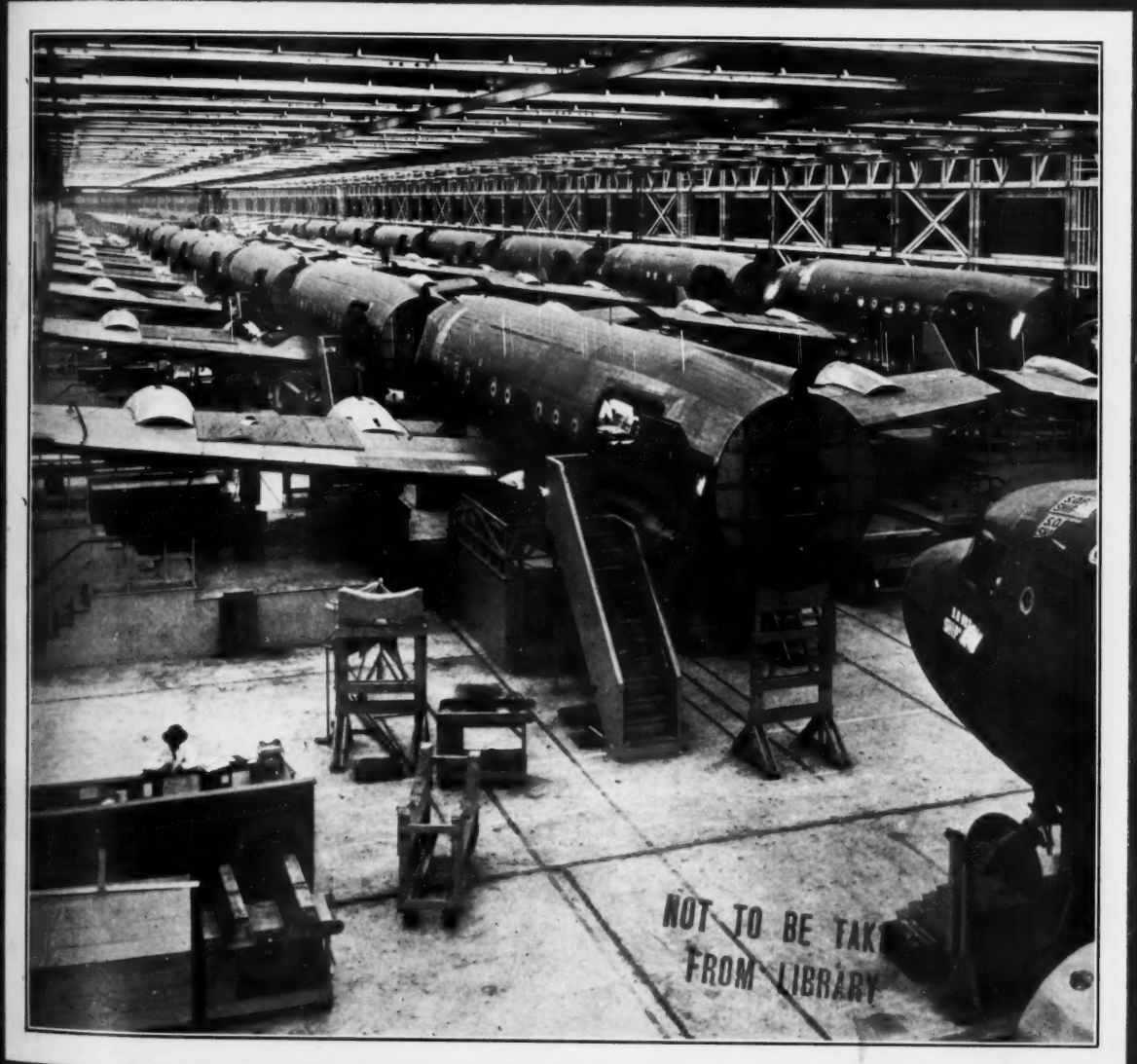
AERONAUTICAL ENGINEERING REVIEW

INSTITUTE OF THE AERONAUTICAL SCIENCES

AUGUST 1944



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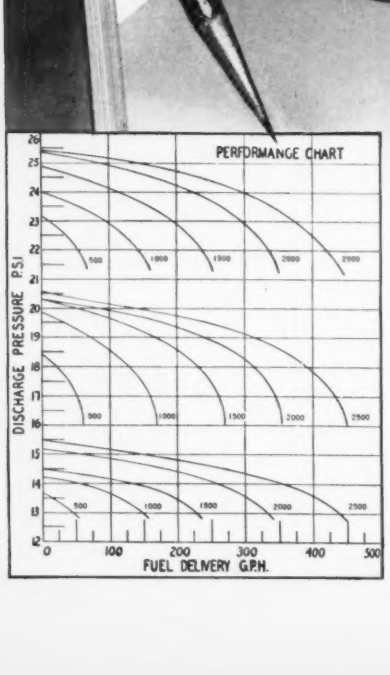

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ABC

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Trail Blazing in the Skies

PIONEERING NEW METHODS

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The Young Engineers' Obligations to the Future

(A Guest Editorial)

DONALD W. DOUGLAS*
Douglas Aircraft Company, Inc.

THE PRESENT WAR has been outstandingly a technical one—a battle of engineers and scientists to provide superior weapons and to get them to the battle front. This has been recognized by people everywhere and technical men carrying this tremendous responsibility have risen in standing and esteem.

When the war is over, different responsibilities, yet ones that may be as critical in preserving our country's existence as we know it and as other young men are fighting for it, must be assumed by engineers.

Our civilization is a technical one and grows continually more complex. To provide employment to many more millions than ever before, new developments and inventions must be brought out. To raise our living standards we must repeat the miracles of the recent past and produce these products with ever decreasing costs. The material means for accomplishing this can be left with confidence to scientists, inventors, and industrial engineers. The uncertainty in the basic economic situation and in the action of government will be reduced as the application of engineering principles and approach in these fields is extended.

Our country faces greater problems than these material developments, and herein lies the real challenge to the young men of the engineering profession. To the world's failure to keep social, political, economic, and moral development abreast of its technical growth may be attributed most of the world's present turmoil. The complexities of our modern engineering civilization are so great that our leaders become confused when faced with the necessity for supplying answers to our problems.

* President.

Never before has there been so pressing a need for clear thinking and broad vision that can evaluate correctly the long-term consequences of different policies and courses of action. This applies to every front: business, labor, and government. Integrity in thinking, knowledge that facts—all the facts—and not wishes underlie sound decisions: these characterize the engineer and are the secret of his success in transforming the material world.

Can he do the same thing when it comes to dealing with men instead of things, with the great social, political, and economic forces of today and tomorrow as well as with the forces of nature? I believe he can, not as an engineering technician, but as a truly professional engineer who has added to his technical knowledge a deep understanding and vision and desire for service. His role will be to advise wisely, to plan creatively, and to correct the myopia which allows a view only of the short-term, selfish advantage.

Increasing numbers of engineers are entering the fields of business and government and bringing to bear on the confused thinking existing there the clear principles of engineering management and engineering integrity. However, the great majority of young engineers will continue in more technical work. They, too, have their obligation to the future: to interest themselves actively in social, economic, and political problems, to act as leaders of thought in their community, to throw their influence on the side of wise progress and against short-range, selfish, or unsound proposals.

It is by such civic-mindedness that engineers will gain an ever widening understanding of the world which they must have if their profession is to fulfill its destiny.

One of the first and most important lessons the engineer learns is that his efforts as an individual are very limited. Only by working in concert with others may his contribution result in great accomplishment. Never has this been so exemplified as in the past three years of war. The miracles of development and production have been made possible only by cooperative research and the pooling of knowledge and experience. Led for the most part by national professional societies, standardization and cooperative effort have made the greatest advances ever witnessed in a similar period. Through a professional society, does an engineer find fullest opportunities for effective work, and for self-development and expression? Merely joining such an organization means little, but by active participation in the society's work, by assisting in molding its aims and policies, the young engineer can lift himself beyond the routine of today's work and with his fellows take a major part in shaping the better world of tomorrow.

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Coating Resins

Flight Research Instrumentation of the Single-Seater Fighter

STEPHEN B. ELGGREN*
Bell Aircraft Corporation

EXACT PERFORMANCE of aircraft and aircraft engines in flight is an imposing and important problem. Since the much needed production of our newest type of aircraft demands an early and complete preview of these prototype aircraft performances, it is mandatory that complete and automatic instrumentation be installed in all such aircraft so that the maximum amount of data on the operation of the engines, controls, and aircraft performance may be secured with a minimum of prototype flight testing. This requirement is greatly accentuated by present wartime conditions. When the near impossibility of maintaining constant flight-operating conditions over any sustained test period and the vital importance of the time element during flight testing are compared with the great amount of vaulable data sometimes wasted yet capable of being obtained during each hour of flight testing, the necessity for securing these data with a minimum of flight testing is seen in its true light. It is toward this goal of complete, accurate, and automatic flight instrumentation that the industry is striving, and the Bell Aircraft Corporation developments in flight instrumentation have been accomplished with this view in mind.

Flight instrumentation and testing have improved steadily in both quality and scope with the advancement of the aeronautical art. The requirements of flight instrumentation vary widely according to proposed uses, but the greatest restrictive requirements are probably embodied in complete flight research programs of small, high-performance aircraft. Suitable instrumentation for such tests must necessarily be small, light, compact, versatile, and easily installed. It must have stable performance throughout wide variations of temperature, pressure, attitude, acceleration, and voltage supply and must also be isolated against vibration. Because of the vast amount of data required during each flight, this type of instrumentation must be completely automatic and capable of being recorded by one or more current recording methods—such as photography, printing or stylus recording, electrical transcription, etc.—so that detailed analyses of the data may later be made.

In large aircraft installations the instrumentation requirements of smallness, lightness, and compactness are somewhat relaxed. However, the necessity for securing flight-test data from many and varied sources in the airplane rapidly enough to present a complete and true survey of the phenomena being measured clearly obviates the continued use of flight personnel for data-recording operations. Since large flight crews are undesirable and continuously recorded data are often required under unfavorable human conditions, the optimum combination is to have a bare minimum of flight personnel observe the operations and results of completely automatic instrumentation rather than record personally the data from manually operated equipment.

BELL AUTOMATIC FLIGHT-TEST INSTRUMENTATION

In order to secure flight-test data that will lend themselves most readily to complete and true analysis, the instrumentation must be capable of receiving, transducing, indicating, and, finally, recording many physical stimuli at closely controlled and correlated time intervals. Also, since automatic operation is immediately dictated by the nature of the tests, devices are necessary which will reliably control and actuate all component parts of any instrument installation at specified time intervals. Development of the Bell automatic flight instrumentation system is the result of such a need, and many of these instrumentation systems have been used successfully during the past year of flight testing (Fig. 1).

This system provides complete and continuous photorecorder surveys of multiple pressures, temperatures, positions, forces, stresses, attitudes, accelerations, speeds, etc. Its operation is automatic and is remotely controlled from the pilot's cabin. Since versatility and standardization of instrument installation and operation are prime requirements, these features have been incorporated into the design of the equipment mentioned above.

Basically, it consists of electrically actuated pressure and temperature switch advance instruments and their appropriate indicators, an electronic intervalometer to govern the intervals of automatic instrument actuation, electrified cameras to record photographically the flight-test data, counters and identification light units for proper correlation of time, and also of the particular survey points being recorded, and a complete set of remote controls for versatile application to flight research sequence and operations.

ELECTRONIC INTERVALOMETER

The intervalometer is an electronic device designed to operate automatic flight instrumentation (Figs. 2 and 3). Its principles of operation are those of gas-filled electronic tubes, together with the time-delay characteristics of a resistor and capacitor connected in series in this thyratron circuit. Essentially, a gas-filled tetrode is caused to conduct, and the resulting flow of plate current within the tube is used to energize a sensitive time-delay relay. This delay period is approximately 0.2 sec. When its contacts close, power is supplied to a second relay, which in turn

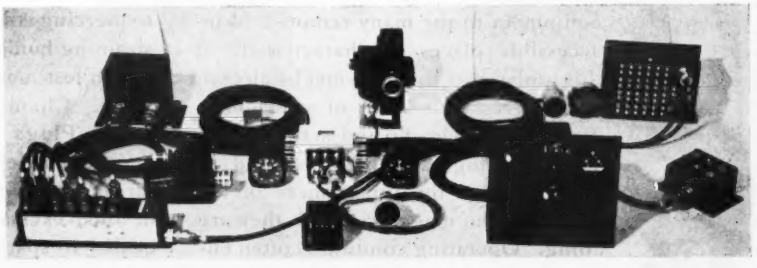

FIG. 1. Bell automatic flight instrumentation.

Presented at the Radio and Instrument Session, Twelfth Annual Meeting, I.A.S., New York, January 25–27, 1944.

* Senior Flight Instrumentation Engineer.

Airborne bulldozer

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C26 — Unshielded

ARMY E NAVY

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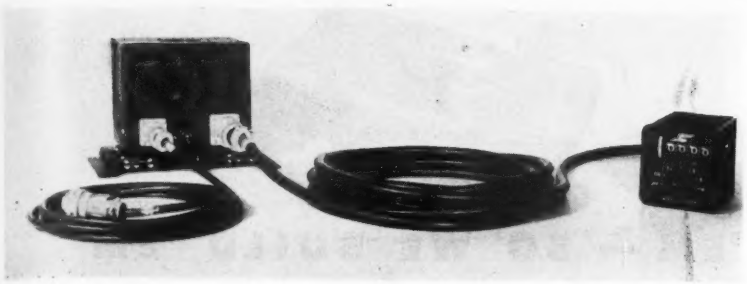


FIG. 2. Single-impulse intervalometer and control.

performs the switching functions necessary for the automatic flight instrumentation system. When the power relay is energized, the external circuits receive an impulse, the time-delay circuit capacitor is charged, and the plate circuit of the gas tube is broken, causing an interruption in its plate current. The time-delay relay and the power relay are thereby permitted to open. This procedure places the voltage of the time-delay circuit on the grid of the tube (i.e., the negative side to the grid), opens the contacts of the external circuit, and replaces the plate voltage on the tube. The negative potential on the grid is allowed to leak off slowly at a rate determined by the delay resistor in the remote-control head. This leak continues until a critical value of negative grid voltage is reached, at which point the gas-filled tube again conducts current and the cycle is repeated. The remote control allows interval selection at will by the pilot of $^1/_2$-, 1-, 3-, 5-, and 15-sec. duration. Since this instrument operates directly from the low-voltage aircraft power source, it does not include rotating or vibrator-type power supplies normally required in electronic flight equipment (Figs. 4 and 5). This type of intervalometer is relatively insensitive to variations of voltage, temperature, pressure, acceleration, etc., and has exhibited reliable and accurate performances throughout the past year of flight testing.

AUTOMATIC PRESSURE AND ELECTRICAL ADVANCING SWITCHES

The automatic pressure and electrical switch advance instruments are capable of 48-point surveys, and the interval between each survey point may be determined by the intervalometer remote control (Figs. 6, 7, 8, 9, and 10). Some special flight tests do not require a full complement of 48 pressure or temperature points in the desired surveys. Consequently, "banking" features allow only portions of the points to become "active"; the remaining ones are "passed" in such rapid succession that no indication is registered on the indicating instruments connected to the electrically operated switch advance units. Therefore, valuable flight and instrumentation time is not wasted when fewer than the maximum number of data points are required. Often flight-testing programs require one complete survey of all pertinent data at many different stabilized conditions of flight, such as altitude, speed, climb, attitude, acceleration, and power. Accordingly, these survey switches are capable of automatically advancing through one complete cycle of required data points and then stopping on a "home position." The next cycle of survey points is started by a push button on the remote control in the pilot's panel when he has attained the next stabilized flight condition specified. The use of these selector switches allows complete coverage of pressure and electrical surveys characteristic of flight testing if the flight stimuli under observation are not changing rapidly enough to introduce error into the survey data because of the short-time intervals between selector switch positions and the inherent dynamic limitations of the indicating meters being used.

REMOTE-CONTROL FLIGHT INSTRUMENTATION

Since space available for experimental instrumentation in the cabin of the Bell P-39, P-63, and other single-seater fighter airplanes is at a premium, it is imperative that flight-test data be recorded by automatic instrumentation somewhere in the airplane other than on the pilot's instrument panel and that only the minimum amount of flight-instrumentation remote controls be placed in the airplane cabin. Remote control units, as described above, allow complete control and operation of this automatic instrumentation (Fig. 11). It is only necessary to place the appropriate controls in a position accessible to the pilot and he is thereby capable of regulating and controlling the manner in which the required flight-test data are secured. The manner in which data are recorded from the remote-control unit may be either continuous or impulsed in operation, as determined by the nature of the flight testing being conducted. When operated under impulsed

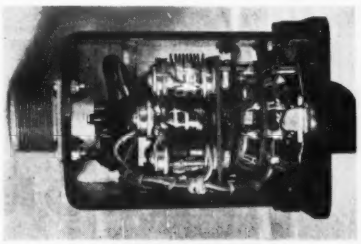


FIG. 5. Single-impulse intervalometer. Bottom view of chassis.

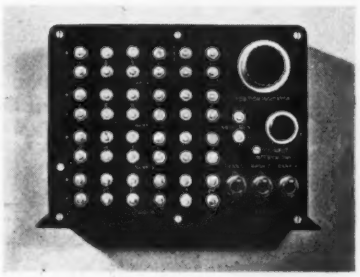


FIG. 6. Banking-type electrical selector switch.

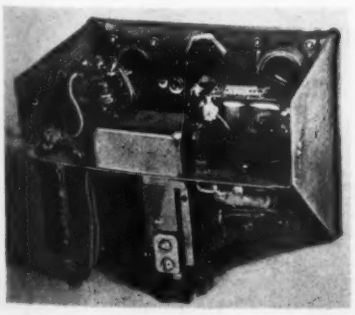


FIG. 3. Single-impulse intervalometer. Rear view of chassis.

FIG. 4. Single-impulse intervalometer control.

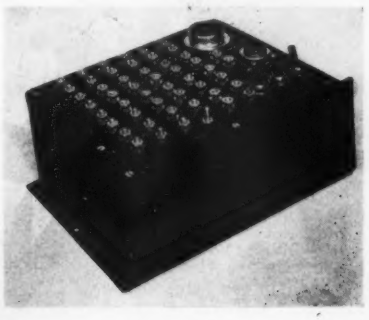
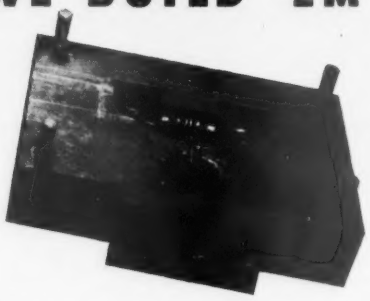


FIG. 7. Banking-type electrical selector switch.

WE CAN'T BUY 'EM — SO WE BUILD 'EM



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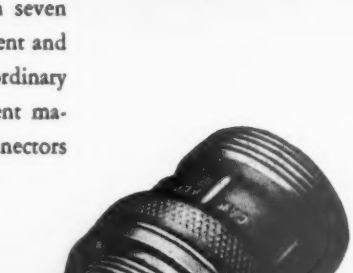

CANNON ELECTRIC

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FIG. 8. Air-scoop pressure distribution survey.

conditions, the instrumentation may be actuated steadily by regulated interval impulses or it may be cyclic, as noted in the description of the air or electrical switch advance units. Automatic instrumentation permits the pilot to devote his entire attention and activities to his actual test flying, a full sized job in itself. Such instrumentation thereby relieves him of all the encumbrances that previously required him to operate the flight equipment and to record manually the rapidly fluctuating flight data from his own instrument panel. Data secured by the pilot alone are, in general, inadequate when considered in the light of the great amount of flight-test data available by automatic instrumentation, the actual cost and importance of flight-test operations, and the relatively small percentage cost required for complete instrumentation of all flight-research programs.

CORRELATION OF PHOTORECORDER DATA

Proper identification of survey flight-test data being indicated in the photorecorder is important if such information is to be used for analysis. To provide this positive identification and correlation with time, electrical circuits have been designed in the switch advance instruments and appropriate electrical signals are sent through cables to identification light units, which are placed next to the switch advance indicating instruments in the photorecorder (Fig. 12).

By supplying current to various combinations of the dial lights of the identification light unit, a maximum number of 63 separate data points can be identified. For further correlation of flight data, electrically actuated counters are incorporated into the design of the intervalometer remote-control unit and similar dual counters are placed in the photorecorder (Figs. 13 and 14). These counters are not cyclic in operation, as are the identification light units described above, but are actuated by separate impulses from the intervalometer and total each impulse consecutively.

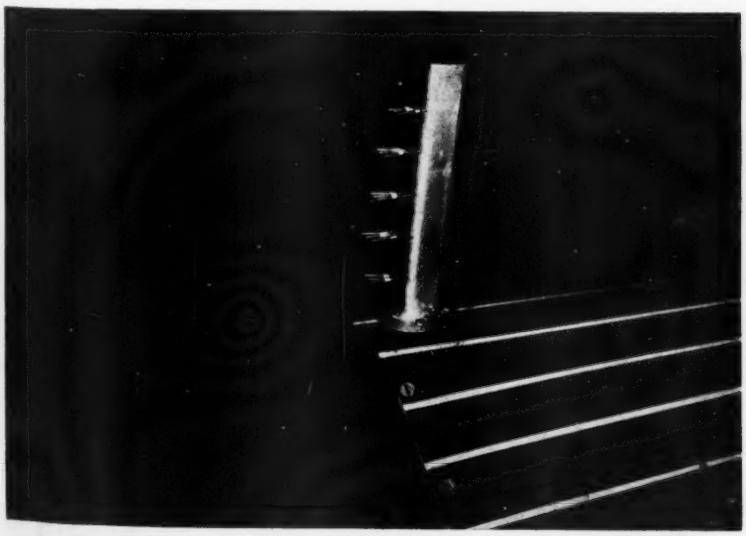


FIG. 9. Carburetor intake pressure survey.

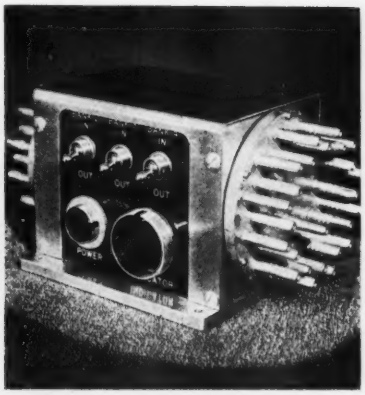


FIG. 10. Banking-type electrically operated air switch.

FIG. 11. Controls for Bell automatic flight instrumentation.

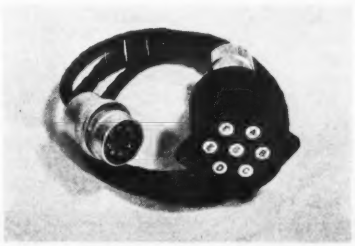


FIG. 12. Identification light unit.

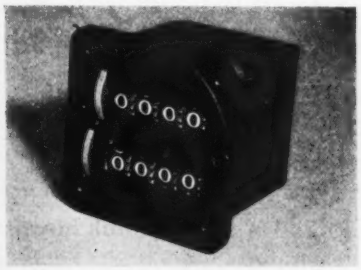
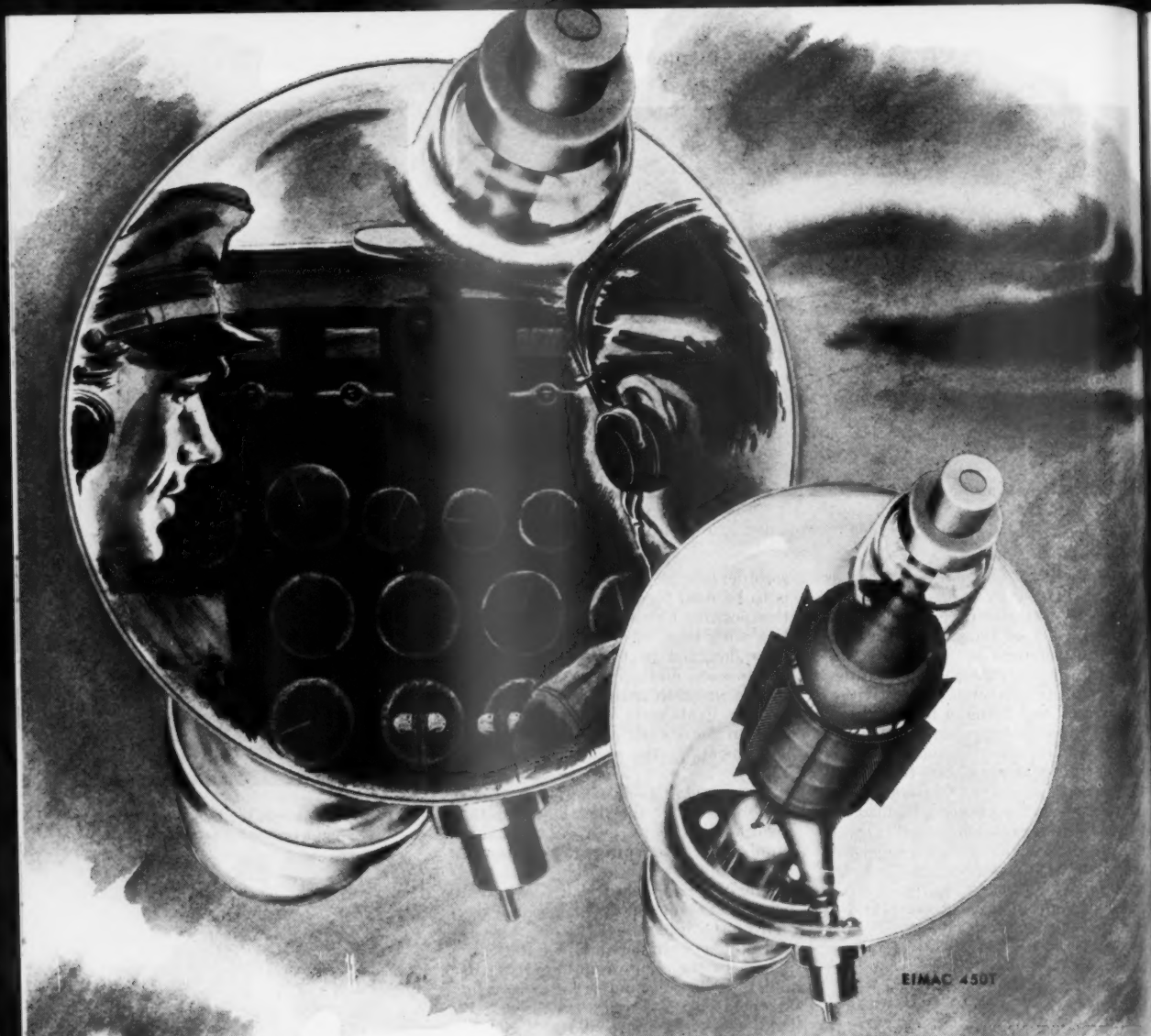
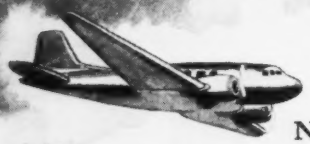


FIG. 13. Flush panel mounting type dual counter.

AUTOMATIC FLIGHT PHOTOGRAPHY

The most suitable camera equipment available on the market has never met the full requirements of flight-test cameras. Accordingly, we have found it necessary to design and construct electrically actuated mechanisms within





partners in AVIATION PROGRESS

No single thing deserves all the credit for winning the conquest of the air. As in most all of man's great achievements, the credit is due to the close partnerships formed between a group of widely separated sciences. A good example is provided by Aeronautics and Electronics.

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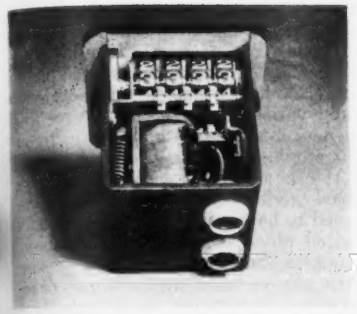

FIG. 14. Internal mechanism of dual counter.

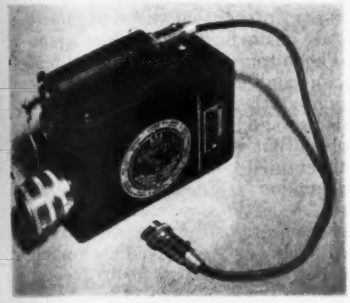

FIG. 15. Electrically actuated Filmo 16-mm. camera altered to allow either single-frame or continuous operation.

FIG. 16. Electrically actuated Eyemo 35-mm. camera altered to allow single-frame and continuous operation.

commercial-type cameras to incorporate additional features of remote control, continuous rewind, and either single frame or continuous operation as determined by the camera remote control in the pilot's instrument panel (Figs. 15 and 16). These camera modifications allow pictures of the photorecorder instruments to be conveniently made at intervals ranging from 64 frames per sec. to 1 frame every 60 sec., as dictated by the nature of the flight-test data desired. Photorecorder installations require wide-angle lenses because of the limited space normally available in modern single-seater fighters and the necessity for maintaining the maximum and most readable instrument data possible. Standard mounts have been designed for wide-angle lenses of various types so that they may be used on any camera (Figs. 17 and 18).

FIG. 17. P-39 airplane showing aft cabin photorecorder installation.

Because of the extensive work involved in reducing a series of flight-test data to a suitable form to allow final analytic comparison, any excessive time delay in film handling and developing is an appreciable expense and, accordingly, must be held to an irreducible minimum. By standardizing our procedures we are able to have photorecorder film developed and ready for use 45 min. after the test airplane has landed.

Power and Control Junction Box

The power and control junction box is primarily a piece of equipment designed to supply, in a convenient manner, both power and control to all of the automatic instrumentation components, such as air switches, electric switches, cameras, intervalometer, etc., and their remote control units (Figs. 1 and 19). This feature allows standardized cables to be used for all probable combinations of flight-test instrumentation programs and required sequences of operation.

Airplane Control Force Instrumentation

Electromagnetic strain gauges form the basis of our airplane control force instrumentation, and the power supplies, oscillators, amplifiers, and indicators were designed around these transducing gauges (Fig. 20). In brief, a small deflection in the control stick or rudder tube changes the impedance of the accurately wound and positioned armature coils within the special electromagnetic strain gauges, and this impedance change is then amplified to a workable value. The output of the gauges is fed directly into the grids of a twin triode tube which form the two

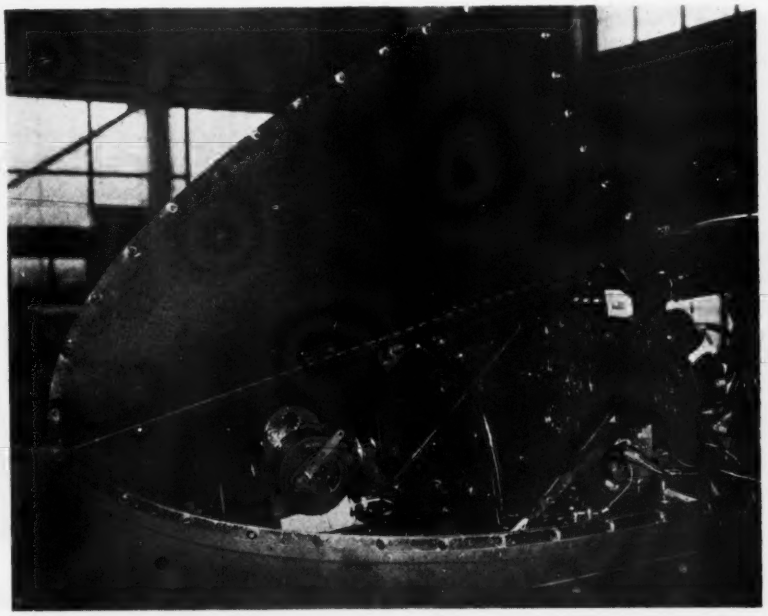

FIG. 18. P-39 aft cabin-type photorecorder installation.

FIG. 19. Main junction box.

variable arms of a balanced bridge. The indicating meters are in this bridge circuit. In effect, the 1,000-cycle carrier signal is modulated by minute deflections of the electromagnetic strain gauges, and the indicating circuit senses both magnitude and direction of the applied control force. The range of forces measurable by this instrumentation is practically unlimited since the gauges can conveniently indicate deflections as small as $^1/_{10,000}$ in., and the actual deflection is a function of the physical characteristics of the members being strained (Figs. 21–27).

In order to secure control force measurements in their most useful form, it is necessary to have indicating instruments of high sensitivity and fast action. Moreover, the indications must be suitable for photorecorder installations. Meters capable of indicating variations of signal strength five to seven times per second and of sufficient scale length to allow satisfactory sensitivity are not available on the market, therefore it was necessary to redesign and alter meters that were obtainable from normal sources of supply. The redesigning of these meters consisted of casting and machining new-type Alnico magnets to provide much stronger magnetic fields, of rewinding the armature coils with considerably more turns of 0.001-in. diameter fine wire, and of replacing the pivot hair springs with much stronger units. New dials were constructed with an overall range of 100 lbs., and with this scale it was possible to indicate force measurements with a sensitivity as great as 1 lb. in 100 lbs. The sensitivity, accuracy, and dynamic qualities of these instruments, as altered, proved to be well within the requirements of airplane control force indicating instruments. Many sets of this control force instrumentation have been constructed and used during experimental flight testing with successful results.

ELECTRONIC CARRIER-BRIDGE FLIGHT INSTRUMENTATION

A relatively simple method of generating electrical intelligence as a function of any specified physical stimulus under observation has been developed in the Electronics Laboratory. In addition to producing dynamic or static indications and being comparatively small in physical size, its output is unaffected by wide variations of carrier-wave frequency, amplitude, and wave form. The intelligence-generating component of this flight instrumentation is a balanced carrier bridge whose arms are designed to be sensitive to changes of any desired physical stimulus under observation. The sensitive bridge pickup arms may be based upon changes of resistance, capacitance, or inductance—whichever parameter lends itself best to registering the required stimuli. The system can be arranged to supply indication through deflection-type meters, tape recorders, oscillographs, or cathode-ray tubes, as dictated by the nature of the flight research program.

The output of the unbalanced bridge is an audio-frequency carrier whose amplitude is a function of bridge unbalance and input carrier amplitude. This output is amplified and fed into a compensated copper-oxide rectifier circuit producing direct current for indication. Variations in carrier amplitude which are normally reflected in the indicator as erroneous readings are automatically compensated for by feeding a portion of the original carrier voltage into a diode rectifier. The resulting direct current is applied as a negative control potential in the amplifier. Thus, the signal available for indication is independent of carrier-amplitude variations. Opposite direction or force discrimination is recognized by the instrumentation and is based on the fact that the output of the a.c. bridge undergoes a phase reversal of 180° as the balance passes through zero. A phase-conscious discriminator is therefore incorporated in the copper-oxide rectifier so that the

FIG. 20. Electromagnetic strain-gauge type elevator and aileron control force transmitter.

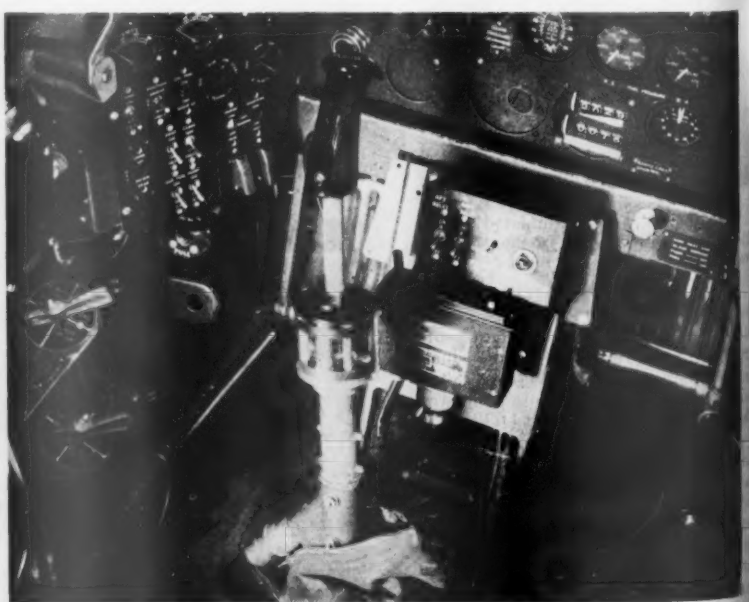

FIG. 21. Airplane installation of Bell control stick force transmitter.

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High above the Himalayas a boxcar-load of men and materials of war speeds toward a distant battlefront, borne on the wings of one of the Army's sky-giants—the Douglas C-54. This huge plane—capable of flying 14 tons of cargo across the Atlantic between dawn and dusk—is an ace-in-the-hole for the United Nations.

Despite its size, the Skymaster is known among Army and airline pilots as one of the easiest-flying and most reliable planes in existence. And B. F. Goodrich equipment helps make its high performance possible. When ice forms on a C-54's wings, B. F. Goodrich De-Icers crack it off. When pilots bring in heavy loads, B. F. Goodrich Silvertown Tires help make their landings smoother and safer. And many other B. F. Goodrich products fly with the Skymaster.

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In war or peace

B.F. Goodrich

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NO, THIS ISN'T A STOCKING STORY. It's about tires... tires made with nylon. The "ladies" are sky queens. They're bombers loaded with every ounce they can lift—any one of the planes sowing devastation over the Reich. They're fighters, too—planes with exceptional performance characteristics.

Naturally, these airplanes are terrors on tires. A fighter really smacks the runway when it drops in at speeds up to 150 m.p.h. And a bomber—loaded to capacity—puts a terrific strain on tires when it has to taxi comparatively long distances from dispersal point to take-off strip.

Ordinary tires—even the best—weren't designed for this kind of treatment. A new tire was needed—one that would be tough enough to stand this terrific punishment yet not be any heavier. Nylon supplies the answer.

But it wasn't as simple as that. Although B. F. Goodrich research men long knew that nylon had great strength characteristics, it took months of painstaking research to overcome its drawbacks sufficiently to make nylon airplane tires practical.

Today, nylon tires are available—although still only for use where specifically requested by the Air Corps. And they *are* successful. Performance figures—comparisons with cotton and rayon cord tires—are impressive. A good example is the B. F. Goodrich 6-ply Nylon Silvertown, which has 35% greater strength than the equivalent 8-ply rayon cord tire. Bruise-resistance is also much higher—up two to four times. Fatigue-resistance has more than doubled.

Commercial and private operators will probably have to wait until victory before they can buy Nylon Silvertowns. But the performance these tires are giving in today's war zones under the toughest kind of operating conditions proves they're well worth waiting for.

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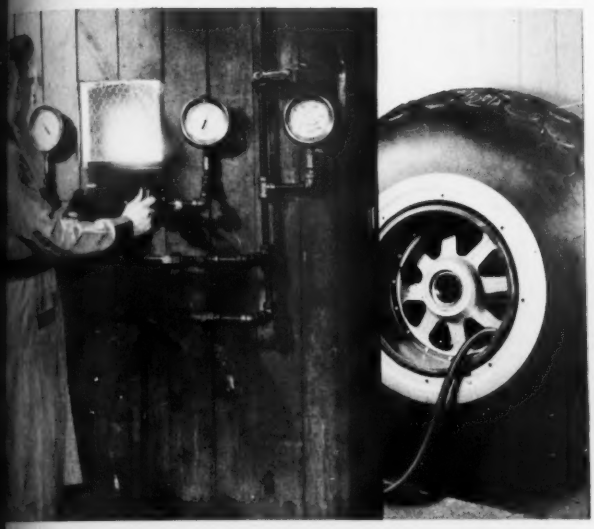
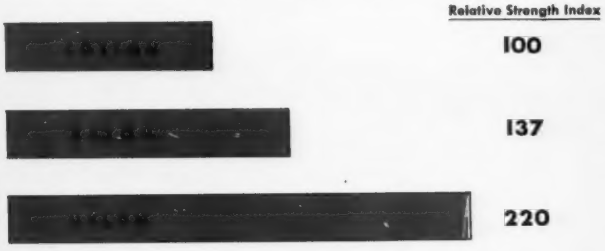
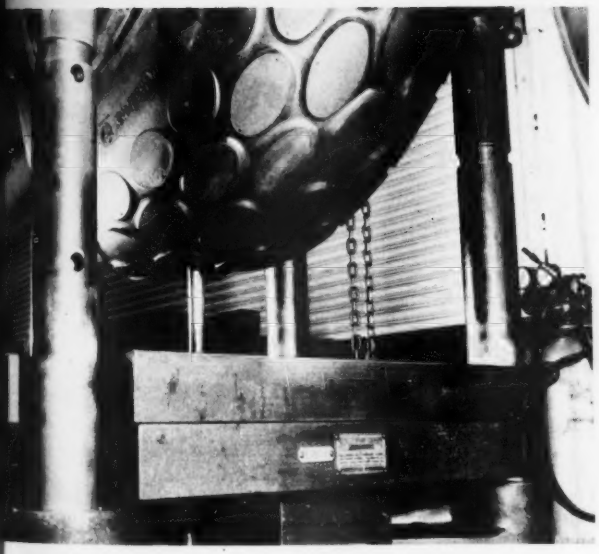


Can tires take the shock when an overloaded bomber hits a bump at high speed? This test says they can. Here a Nylon Silvertown is inflated with water under high pressure until the tire bursts. The dial records a comfortable operating factor of safety for each tire type tested.

Tensile Strength Comparison of Cotton, Rayon and Nylon Cords of Equal Size



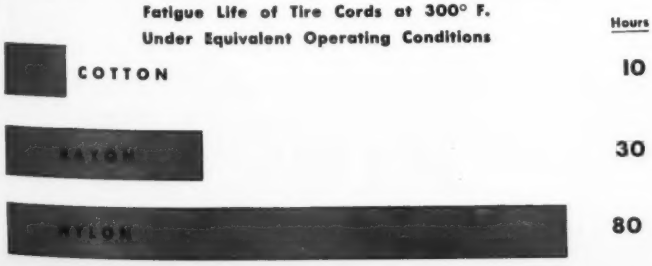


How about bruise-resistance? This test proves that overloaded bombers can do a lot of taxiing over rough fields without bruising their nylons. As the chart below shows, Nylon Silvertowns have greatly increased bruise-resistance over those made with rayon cord.

Relative Tire Bruise-Resistance at 50-Lb. Inflation

Fatigue-resistance of nylon tire cords is greatly superior to that of rayon and cotton. That's why Nylon Silvertowns stand up under the toughest kind of operating conditions. The chart here graphically shows this important nylon advantage.

Fatigue Life of Tire Cords at 300° F. Under Equivalent Operating Conditions



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- Deep counterbore for easy screw insertion

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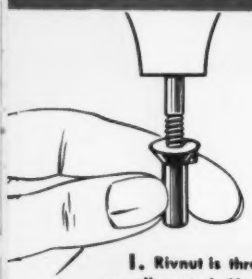
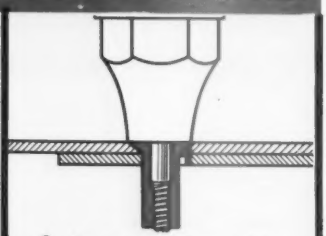
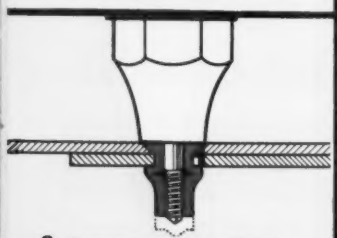


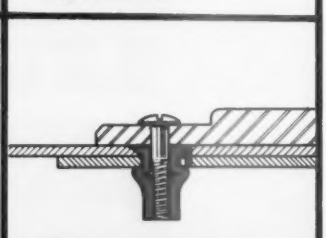
1. Rivnut is threaded on pull-up stud of heading tool until it touches the anvil.



2. Rivnut and pull-up stud is placed in hole with Rivnut head firmly against, and at right angles to, the work.



3. A squeeze on the tool lever retracts pull-up stud slightly, causing a lateral bulge upset of the Rivnut.



4. When pull-up stud is removed, the Rivnut can be used as a nut plate. Threads grip accessory screw firmly.

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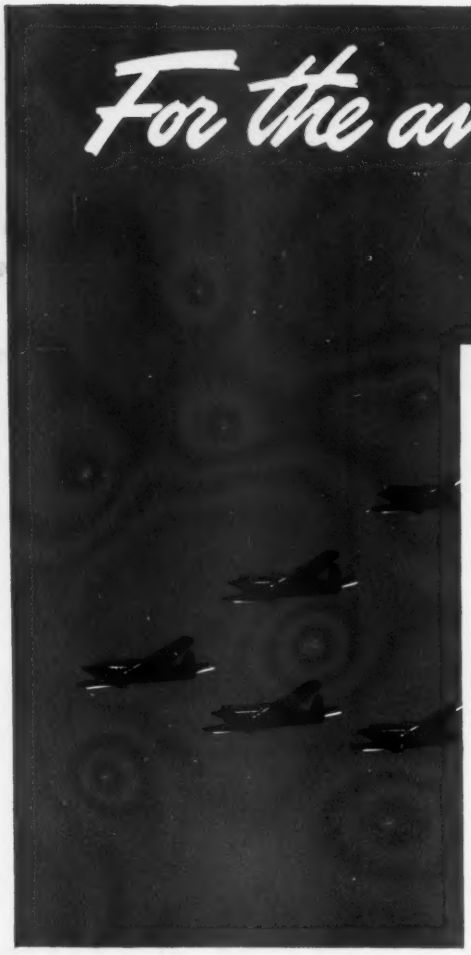

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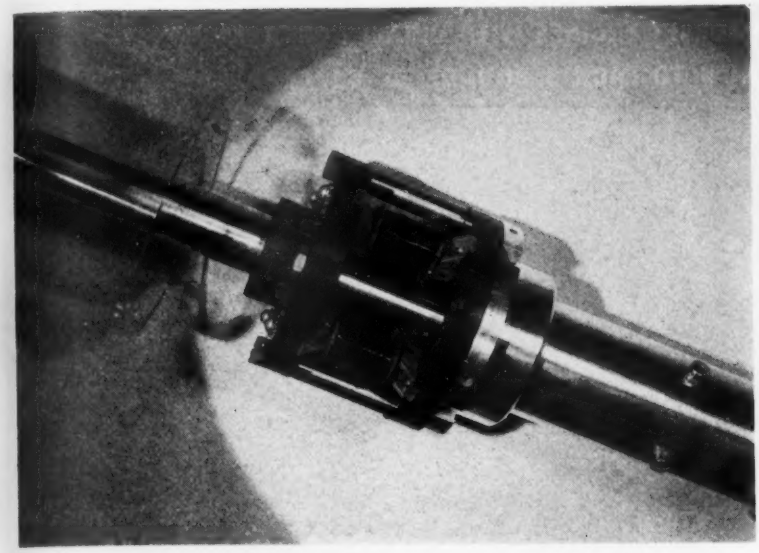


FIG. 22. Close-up of control stick force transmitter showing details of coils, laminations, and supports.

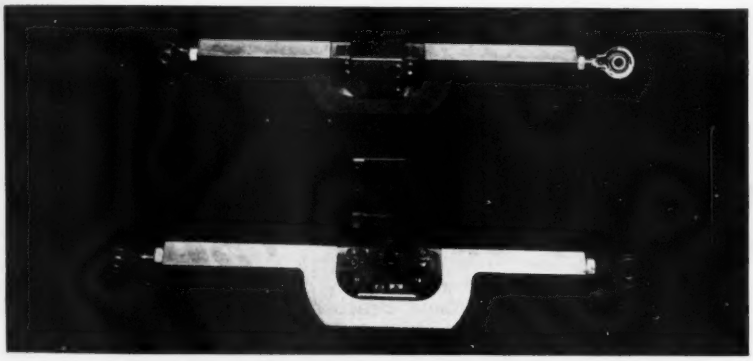


FIG. 23. Electromagnetic strain-gauge-type rudder force transmitters.

FIG. 24. Electromagnetic strain-gauge-type rudder force transmitters.

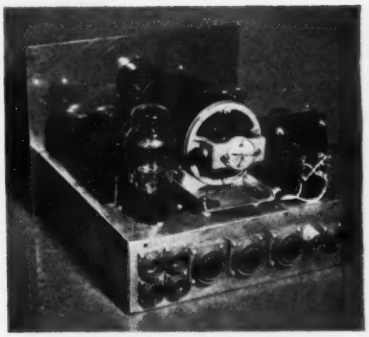


FIG. 25. Top inside view of Bell four-channel oscillator-amplifier airplane control force instrumentation.

polarity of the d.c. output reverses when the phase is reversed. Since the two voltages from the amplifier and oscillator originate from a common source, the electrical addition or subtraction of the vector components as determined by their phase relationship in the discriminator circuit is independent of carrier frequency and wave shape.

As noted before, variations of carrier frequency, amplitude, and wave shape do not produce erroneous indications, and therefore a small rotary d.c. inverter is used as the power and oscillator source. Multiple channels of this type of instrumentation for specified flight testing portend substantial savings in space and installation time.

AUTOMATIC TEMPERATURE RECORDING

An automatic Brown pyro-potentiometer (Fig. 28) has been used in flight testing for the past year. As a result of this testing, alterations were found necessary in order to render the instrument suitable for reliable operation in small, high-performance, pursuit aircraft. Briefly, these changes provided for remote control and indexing for flight-test data correlation; appropriate circuit changes to allow resistance-type strain gauge measurements for position, altitude, air-speed, and force indications; and extensive revisions in the thermocouple lead switch boxes to eliminate error-producing thermoelectric effects in the dissimilar metal terminals due to the temperature differentials at these points caused by the rapid ambi-

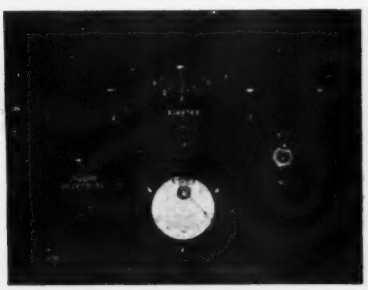
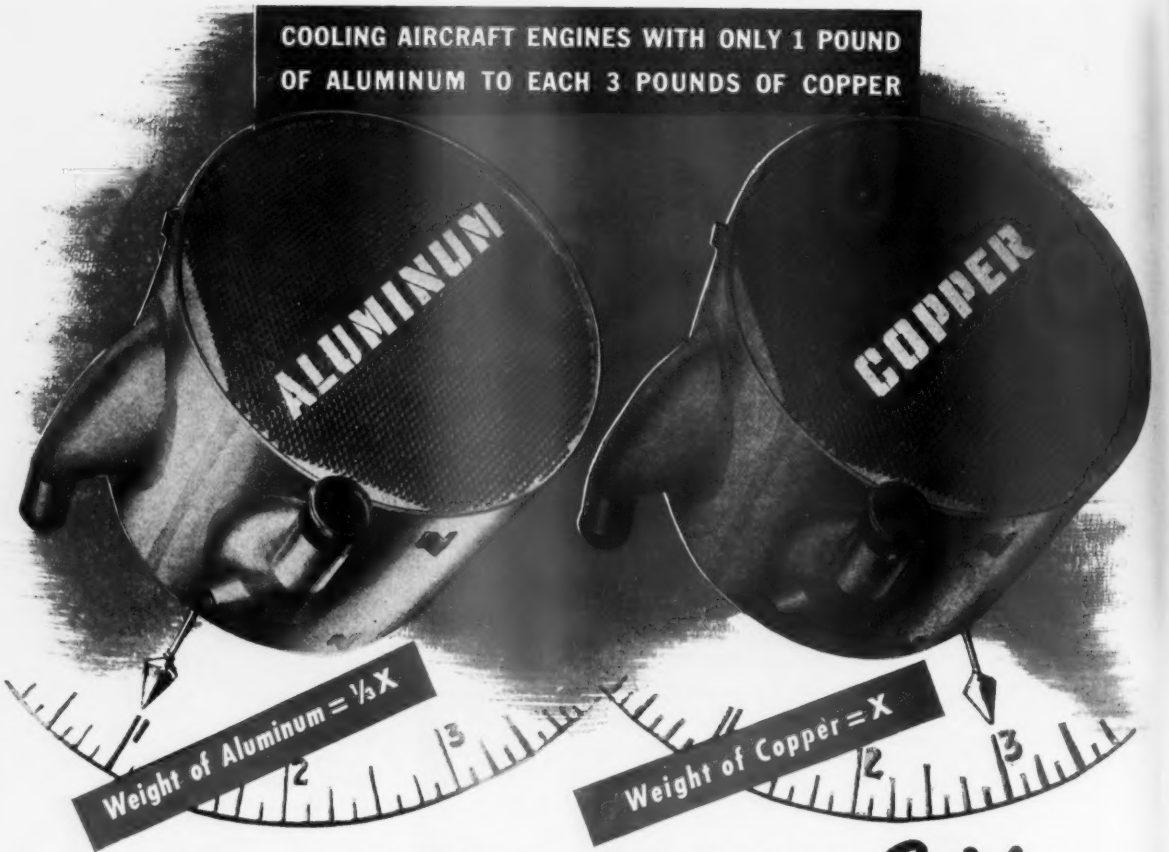


FIG. 26. Bellf our-channel oscillator-amplifier airplane control force instrumentation.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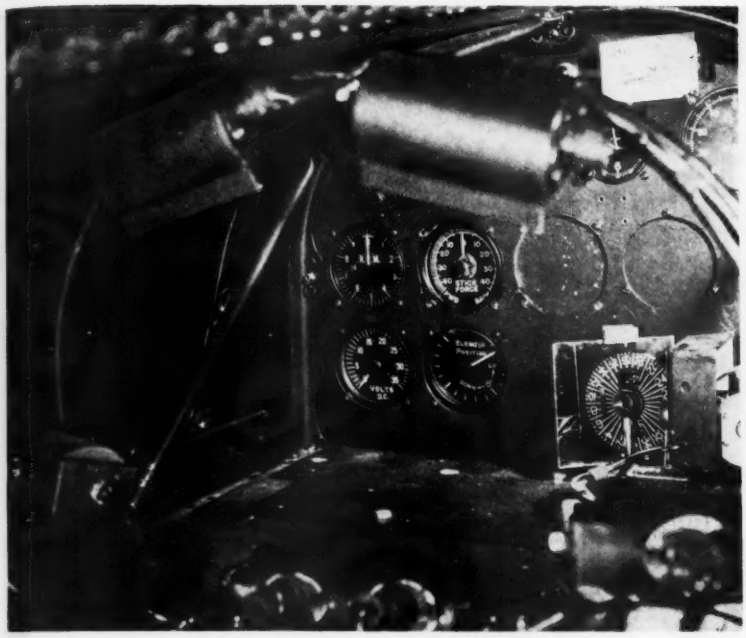

FIG. 27. Photorecorder installation showing elevator stick force, elevator position, and gyro adapted to indicate rate of pitch.

ent temperature changes experienced by high-performance pursuit aircraft as they are flown through their rigorous flight tests. (See Figs. 29 and 30.) When airplane space available for instrumentation does not permit or when flight testing does not require temperature surveys as extensive as that possible with a Brown recorder installation, the electrical advancing switches described previously are used in combination with other Bell automatic instrumentation at a proportionate saving in installation time.

FLIGHT INSTRUMENTATION REQUIREMENTS

The designer of flight-research instrumentation is confronted with perhaps the greatest combination of error-producing variables ever presented as an instrumentation problem. A few of the most important variables to which flight instrumentation must necessarily be made insensitive are as follows:

(A) *Temperature*—Flight instrumentation must exhibit true compensation and complete accuracy of all indications throughout a temperature range of +75° to −65°C.

(B) *Pressure and Density*—Satisfactory operation and indication must be maintained throughout a pressure range of 2 to 15 lbs. per sq. in.

(C) *Vibration*—Instrument components must exhibit reliable operation and indication even though subjected to vibrations of high intensity and large amplitude throughout the wide frequency spectrum characteristic of combinations of reciprocating engines, gear boxes, propellers, and aircraft structures. The ratio of power developed to engine-mounting weight for small aircraft far exceeds all other power installations, and the resulting vibration problem is aggravated proportionately.

(D) *Supply Voltage*—Flight instrumentation must be capable of producing true indication of measured stimuli regardless of supply voltage variations of ±15 per cent.

(E) *Attitude and Acceleration*—All instrumentation must be designed to be unaffected by rapid changes in attitudes and sustained or cyclic acceleration loads of from $-4g$ to $+9g$.

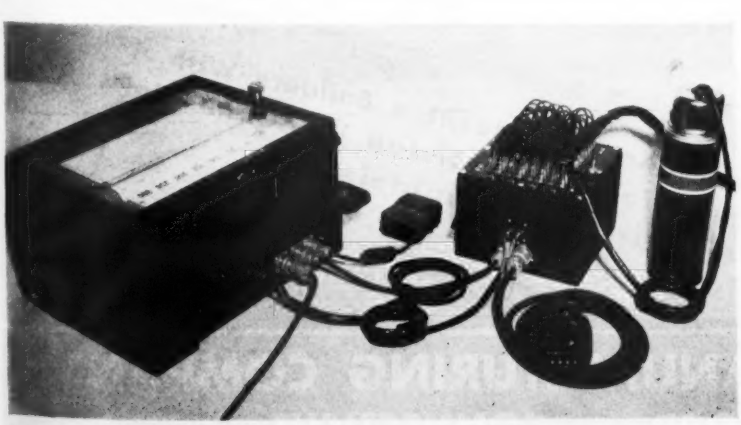

FIG. 28. Brown recorder system.

CURRENT INSTRUMENTATION DEVELOPMENTS

Major developmental programs of particular interest to Bell Aircraft Corporation and presently receiving the attention of its Flight Research Division include, among others, the following: (A) flight thrustmeter instrumentation; (B) flight engine detonation instrumentation; (C) flight torquemeter instrumentation; (D) electronic frequency meter tachometers; (E) cathode-ray photorecording; and (F) continuous-line dynamic flight recorders.

CONCLUSION

As the field of flight instrumentation increases in scope, intensity, and purpose, it becomes readily apparent that

FIG. 29. Remote control for Brown automatic temperature recorder.

the instrumentation development engineer must know the fundamental theories and principles underlying the phenomena that he is attempting to explore. This knowledge must necessarily include aerodynamics, mechanics, dynamics, structural analysis, electronics, etc. It also follows that the engineer who analyzes flight research data should know the fundamental principles and operations upon which the many types of flight instrumentation "black boxes" are based so that he may understand the inherent limitations of all flight instrumentation and interpret the results accordingly. The engineer who analyzes flight research data with such a basic knowledge of flight instrumentation principles is more apt to glean the maximum amount of useful information from any set of flight-test data, and he is less apt to arrive at erroneous conclusions because of wrong interpretations of both normal and abnormal instru-

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mentation operations. Moreover, a fundamental understanding of this nature also allows instrumentation to be used to the fullest extent of its capabilities.

Although flight instrumentation has advanced considerably with regard to increasing the sensitivity and accuracy of flight-data measurements and in broadening the scope of flight testing and data recording, it is still an infant when compared with most other types of instrumentation. Intensive research and further development are therefore dictated for flight instrumentation, and appropriate paths of endeavor are:

(1) Development of continuous line recorders to secure the desired flight-test data by means of continuous lines on a roll of paper, which *data are ready for immediate observation and evaluation by the flight research engineer.* This instrumentation may be designed to operate either in the aircraft during flight or at ground stations that are controlled by radio transmission of flight data from aircraft. The true economy of the expenditure of money and developmental time for such timesaving instrumentation is plainly evident when it is compared with present inefficient methods of film developing, reading and plotting in continuous line form prior to any analysis whatsoever.

(2) Development toward increased sensitivity, range, and accuracy within practical limits.

(3) Development and simplification of dynamic-type instrumentation. The present systems of dynamic flight instrumentation consist of mechanical stylus or torsion-wire galvanometer-type recording oscillographs and multiple cathode-ray tube photorecorders, and present users of this instrumentation would admittedly welcome a developmental program devoted to its simplification.

The field of aircraft dynamics is progressively encompassing a larger variety of design and flight research activities, and, as a result, a considerable amount of research work has been done in the development of suitable dynamic-type flight instrumentation. *It is especially important to note that progress has been made in this field of research only as rapidly as appropriate flight instrumentation has been designed, developed, and flown to secure the dynamic flight-test data required.* This situation is typical of the relationship of all research to instrumentation problems, and the aircraft industry in general will be well repaid if it establishes and promotes

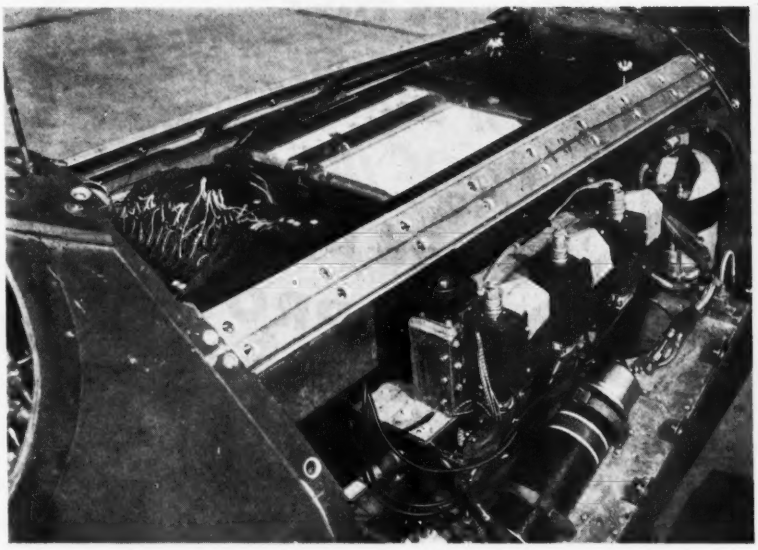

FIG. 30. Typical P-39 automatic temperature survey instrumentation.

organizations to design and develop instrumentation to meet the many present and future needs in this field. *Every advancement in the field of flight instrumentation opens vistas for research into new flight phenomena and is therefore a notable contribution to the aeronautical art.*

During any flight test program the effective *"quantity of answers" is a direct function of the speed with which data can be secured for analysis. It is evident that even an unlimited supply of capable engineering man power will not increase the number or speed of these answers that directly affect all engineering, production, and corporate finances if these flight research data are not forthcoming in sufficient quantity.* Delays in production result in losses sustained by the manufacturer and may be evaluated on the basis of the profit normally earned per airplane times the number of planes affected by the delay. *Facts indicate that with a production of 70 planes per month, valued at $75,000 each, a three months' delay could result in a loss in excess of $1,000,000 to the manufacturer.* Accordingly, instrumentation must be available and properly used so that the desired answers may be obtained immediately after completion of a flight. Long-range preparation of instrumentation is therefore necessary so that appropriate data may be obtained quickly and accurately.

We at Bell Aircraft Corporation have discovered extensive uses for our automatic flight instrumentation. This has resulted in our securing the maximum amount of flight research data per flight time, which is immediately reflected as a material saving of expense to the Corporation. If all or any part of these automatic flight instrumentation systems will assist other organizations in their flight research activities, we shall be most happy to cooperate in any way possible.

All prototype aircraft should have complete and appropriate instrumentation on board for every flight to record data regarding all possible phases of airplane flight, structural and dynamic characteristics for the purpose of either substantiating present design criteria or presenting data by which new design theory may be formulated. *By the continuous use of appropriate instrumentation during all experimental flights and by methods of statistical analysis, appropriate design criteria for production models may be rapidly established.* Aircraft development during the experimental stages as mentioned above, and not development by "unsatisfactory reports" from customers after the airplanes have been placed in service, is the most business-like manner of engineering design, and this is the ultimate goal toward which all aircraft design and manufacturing organizations are striving.

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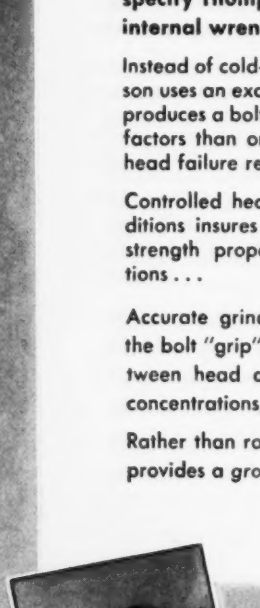

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Sandwich Construction

N. J. HOFF* and S. E. MAUTNER†

Polytechnic Institute of Brooklyn and Skydyne, Inc.

SYNOPSIS

The characteristic feature of sandwich construction is the use of a multilayer skin consisting of high-strength faces and a low-weight core. The material of the faces may be plywood, laminated paper, or aluminum alloy; that of the core, cork, balsa wood, or synthetic material. This skin is very stable and permits the building of monocoques without stiffeners. The results of strength tests with the sandwich skin loaded in tension, torsion, and bending are reported, and the manufacturing procedure of a sandwich-type aileron is explained in some detail with photographs. The advantages of sandwich construction are discussed from the design and manufacturing standpoint.

WHAT IS SANDWICH CONSTRUCTION?

THE CHARACTERISTIC FEATURE of the sandwich construction is the use of a multilayer skin consisting of one or more high-strength outer layers (faces) and one or more low-density inner layers (core). In particular, airplane structures built according to the sandwich principle are true monocoques—that is, they are hollow bodies having a comparatively thin skin of the sandwich type which carries all the loads imposed upon the structure and at the same time provides an aerodynamically clean, smooth, streamlined surface. In sandwich monocoques inner bracing elements are needed only where concentrated loads are applied, so that elsewhere the entire interior of the structure is available for crew, passengers, cargo, and equipment.

The use of a low-weight spacer between the high-strength load carrying layers of the sandwich skin results in a light, yet stable skin construction that does not buckle under the loads that occur in flight and at landing. Materials at present available for the faces are plywood, wood pulp fibers, and aluminum alloy, for the core, cork, balsa wood, and synthetic materials such as cellulose acetate.

HISTORICAL DEVELOPMENT

True monocoque airplane structures consisting only of a strong, thin, lightweight, smooth shell with no external or internal bracing elements have long been the dream of the airplane designer. They enclose the motor, pilot, passengers and cargo with the least amount of waste space, and thus their cross-sectional area is held to a minimum. Moreover, their surface is smooth and their shape streamlined. For these reasons monocoques offer the smallest possible resistance to flight and are ideal for economic air transportation.

When in the nineteen twenties the First World War type biplane was abandoned in favor of the streamlined monoplane, efforts were made to build the monoplane as a true monocoque. It turned out, however, that the monocoque skin buckled under small compressive or shearing stresses and the structure collapsed prematurely unless it was reinforced internally. In some of the wooden monocoque fuselages built in those days the reinforcing elements were only transverse rings, also known as frames or ribs. The great weight of this construction, the heterogeneity of wood and its low resistance to humidity, as well as the general dislike of engineers for wood soon resulted in the replacement of wooden monocoques by aluminum structures.

Unfortunately, aluminum-alloy sheet is even more liable to buckle than commercial plywood is. Thus, it was necessary to add longitudinal reinforcing elements to the transverse rings to keep aluminum alloy aircraft from failing at low values of the stress. The longitudinal reinforcing elements are known as longitudinals, stringers, or cap strips.

The design and manufacture of the aluminum-alloy reinforced monocoque, or semimonocoque, was developed to great perfection in the nineteen thirties. As is well known, practically all the modern fighter and bomber planes are built as semimonocoques. According to present-day practice, greatest stability and strength coupled with smallest weight are attained if the sheet metal used for covering, as well as for bent up or drawn reinforcing sections, is extremely thin and the number of reinforcing elements large.

Disadvantages of Present-Day Practice

The drawbacks of this type of construction are rather obvious. It contains so many small, thin-walled elements riveted together that its manufacture is expensive. Jenkins stated in a recent paper[1] that there are 3,000,000 rivets in a large-sized aircraft and that approximately 50 per cent of the total cost of the air frame is made up of the cost of fastening together the many pieces that constitute the structure. In the authors' opinion the modern aluminum-alloy semimonocoque attained its present form mainly because the development was brought about by big orders of the armed forces who are not deterred by high production cost. Under present conditions the only way to build airplanes even halfway economically is to build them in series greater than presumably ever needed in peacetime production. With smaller orders the cost of tooling up for series production is prohibitive.

Since the reason for the complexity and high cost of the structure is the low stability—that is, the liability of the aluminum-alloy skin to buckle—the obvious thing is to look for another skin that does not have this drawback. It is known that the stability of the skin depends primarily on its thickness. Therefore, low-density materials that can be used in thick gauges without increasing the structural weight are at a premium for monocoques. It appears, however, that no single material is now available that combines the required light weight with the necessary strength. It is logical, therefore, to make use of a thick layer of ultra-lightweight material sandwiched between two layers of thin, but strong sheet.

The authors are unable to present a complete history of the idea of the sandwich construction in aircraft. To their knowledge the earliest description of a sandwich wall is contained in a patent granted in 1924 to von Kármán and Stock.[2] S. E. Mautner began experimenting with a plywood-cork sandwich system in 1934 in the airplane plants of the Schneider-Creusot concern in France. In 1938 he showed at the Salon d'Aeronautique a low-priced cabin monoplane having a sandwich wing. In Great Britain de Bruyne[3] has been working for many years on the utilization of reinforced plastics in aircraft. It appears that the sandwich system was first adopted in England in the fuselage and in the leading edge of the aileron of the DeHavilland Albatross. The system attained world-wide publicity when it was disclosed that the almost legendary DeHavilland Mosquito bomber had a sandwich-type fuselage.[4] As far as is known the first sandwich airplane part manufactured in this country was an aileron built by Skydyne in 1939.[5]

STRENGTH AND STIFFNESS OF THE SANDWICH SKIN

Experimental Data Available

There is little information available in technical literature on the strength and stiffness of the sandwich construction. Some data are contained in an article by Gough, Elam, and de Bruyne,[3] published in 1940, and in a more recent one by Gordon[6] published in 1943. In the past year experiments have been made with sandwich-type test specimens at the Polytechnic Institute of Brooklyn by Albert J. Culleu and Joseph Kempner under the direction of N. J. Hoff. A short report is presented here on three test series on tension, torsion, and bending, respectively, carried out with sandwich material having a balsa core and spruce plywood

Presented at the National Light Aircraft Meeting, I.A.S., Detroit, April 27–28, 1944.

* Associate Professor of Aeronautical Engineering; Consultant, Skydyne, Inc.

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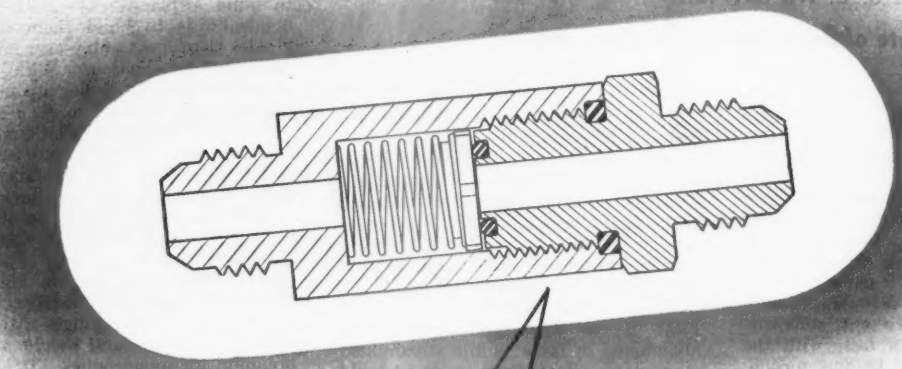

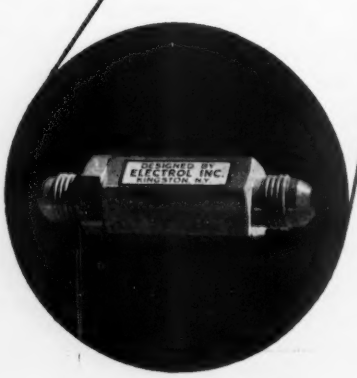

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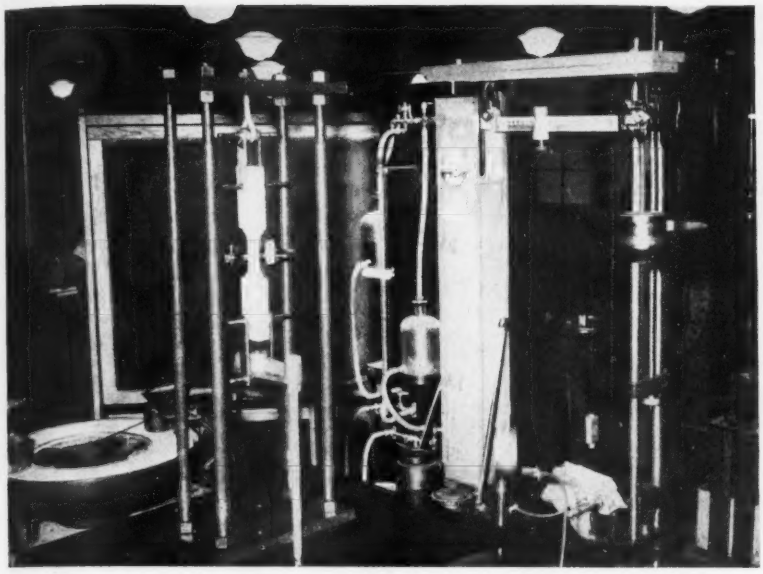


FIG. 1. Tension test setup with Huggenberger extensometers.

faces. These tests were considered preliminary to a more intensive research program, and no attempt was made in them to control the moisture content of the wood or to establish averages of great numbers of individual tests. Consequently, there was a considerable amount of scatter in the test results. Nevertheless, it was possible to observe typical trends, which are reported here.

Tension Tests

In the tension test series altogether 20 specimens were tested. All specimens had spruce plywood faces consisting of two mutually perpendicular veneers $^1/_{64}$ in. thick arranged at 45° to the direction of tension. The thickness of the balsa core varied from $^1/_{16}$ to $^1/_2$ in.; the specific weight of the balsa, from 10.4 to 15.0 lbs. per cu.ft.; and the fibers of the balsa wood were parallel to the direction of tension.

The tests were carried out on a Fairbanks lever-type testing machine of 2,000-lb. capacity. The test specimens were attached to the machine by means of pins and lugs to insure absence of end moments. Fig. 1 shows the test setup; Fig. 2, broken specimens. In about half the tests, strains were measured by Huggenberger extensometers; in the other half, by Baldwin-Southwark metalectric strain gauges. Separate strain readings were made on the two faces of each specimen, since the presence of a bending moment could be detected from the occurrence of differences in the strain readings. When such differences were noticed the specimen was shifted until the two gauges gave identical readings. This procedure was considered necessary because of the variations in the elastic properties of wood which may give rise to bending moments even though the load is applied along the geometric centerline of the specimen. The accuracy of the load readings was ±1 lb. The Huggenberger extensometers had a magnification of approximately 320 and could be read with an accuracy of about 10^{-4} in. per in., while the accuracy of the electric strain readings was of the order of 10^{-6} in. per in. For each specimen strains were plotted ag..inst loads, and in each case the curve obtained was straight up to failure. A typical plot is shown in Fig. 3. An average ultimate tensile stress F_{tu} was obtained from the test data by dividing the load by the total cross-sectional area of the specimen, and an apparent modulus E_{ap} was calculated by dividing the difference between two suitably chosen average stress values by the corresponding difference in

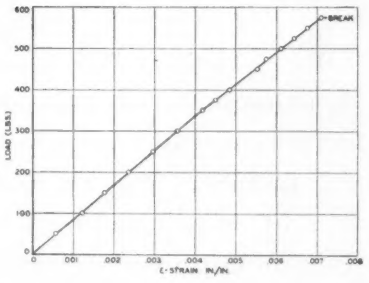


FIG. 3. Typical load-strain diagram in tension.

FIG. 2. Tension test specimens after failure.

strain. The averages of the twenty test values are:

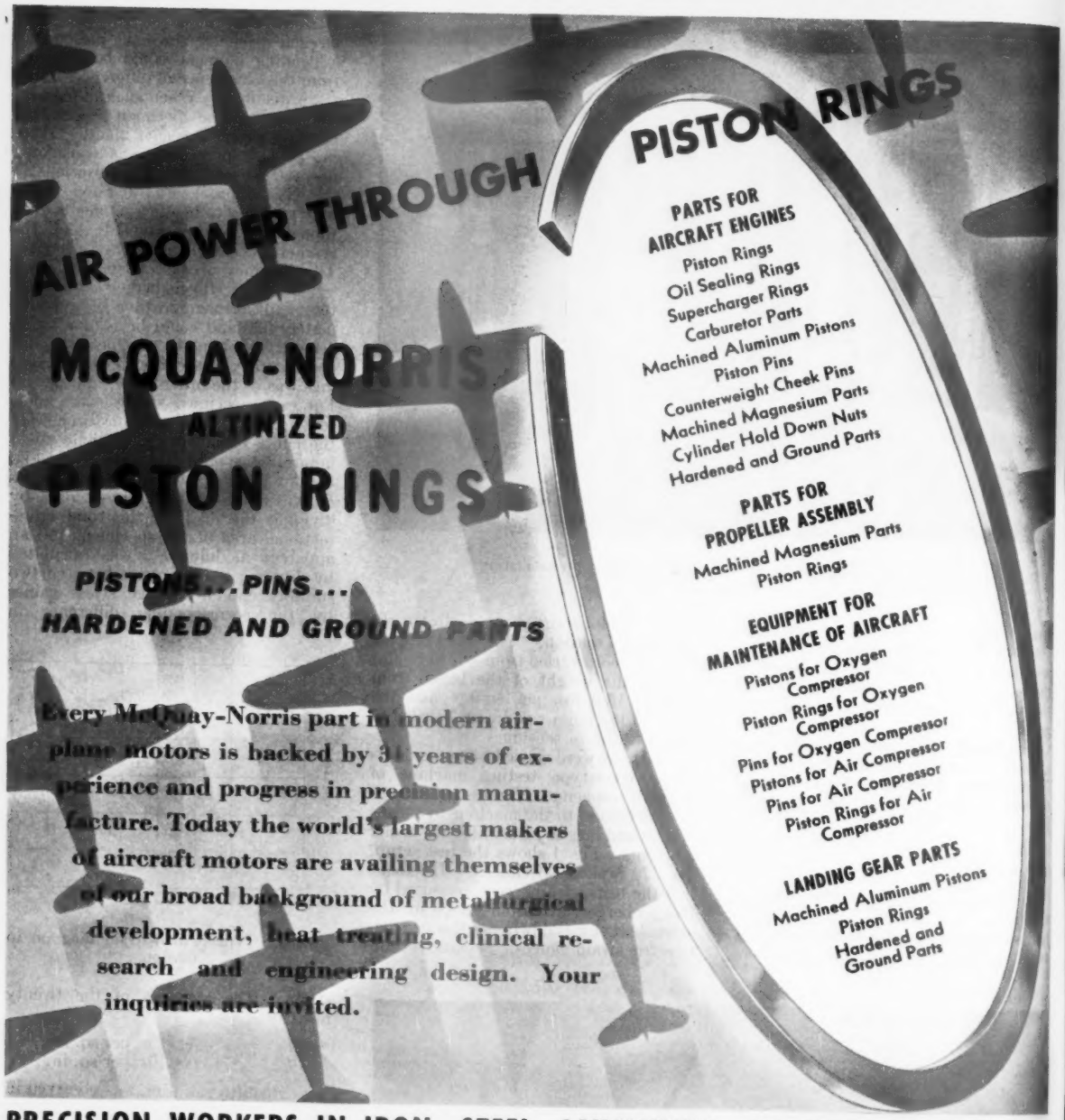
F_{tu} = 3,500 lbs. per sq. in.
E_{ap} = 715,000 lbs. per sq. in.

No definite variation was observed in the values of the failing stress with increasing thickness of the balsa core or with increasing density of the balsa wood. However, a slight trend toward increasing values of the apparent modulus with increasing thickness of the core and increasing density of the balsa wood was noticed.

It is well known that plywood is little suited to carry tension applied at an angle of 45° to the direction of the fibers. It must be concluded, therefore, that the tensile strength of this type of sandwich skin is derived almost entirely from the balsa core. The strength to weight ratio was not unfavorable, since the average weight of the sandwich skin was only 16 lbs. per cu.ft.

Torsion Tests

In the second test series 17 specimens were tested in torsion. The basic group in this series consisted of three circular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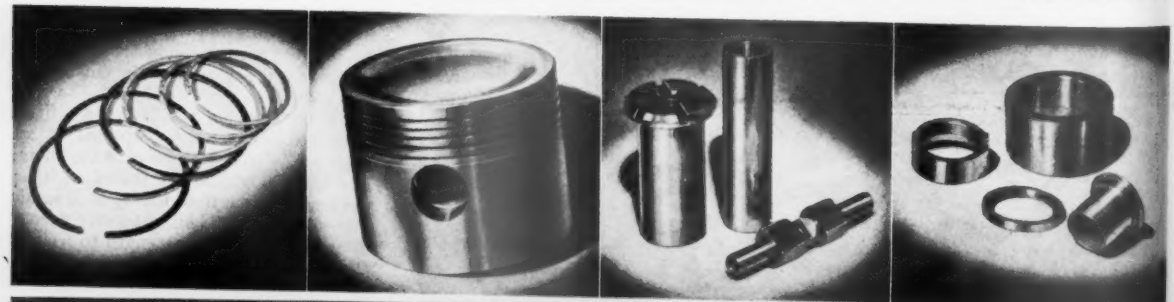

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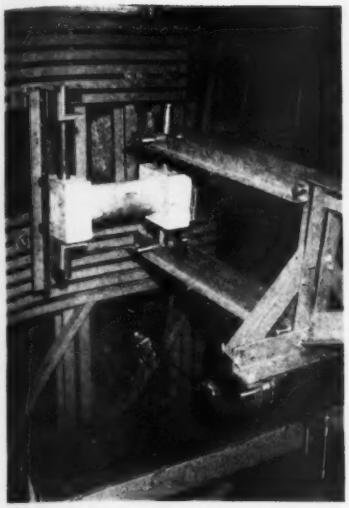

FIG. 4. Torsion test setup.

cylindrical specimens of 3⅝-in. overall diameter and 9-in. clear length. The sandwich wall contained a balsa core of ⅛-in. thickness and two plywood faces each consisting of two 1/64-in. spruce veneers. The fibers of th veneers were mutually perpendicular and subtended an angle of 45° with the axis of the cylinder. The test setup is shown in Fig. 4; two specimens after failure, in Fig. 5.

An oak plug was inserted into each end of the cylinder and an oak block glued around it in order to permit an application of the load without causing stress concentrations in the sandwich wall. One end of the specimen was fixed to the test stand, and a pure torque was applied at the other end through a parallel linkage. The latter was pinned to a loading triangle that rested on ball bearings and was loaded through a mechanical jack. The load was measured by means of a load link to which Baldwin-Southwark metalectric strain gauges were cemented. Relative angular displacements of the two end blocks were measured with the aid of long steel scales and hands.

FIG. 5. Torsion test specimens after failure.

A typical torque-twist diagram is shown in Fig. 6. As may be seen the curve is not straight. Its initial slope was used to determine the initial apparent shear modulus G_{ap} of the sandwich skin. The apparent shear stress at failure was calculated from the formula

$$F_{su} = T_{max.}/(2At)$$

the apparent initial shear modulus G_{ap} from the formula

$$G_{ap} = TSL/(4A^2t\alpha)$$

where

T = the applied torque in in.lbs.
$T_{max.}$ = the maximum applied torque in in.lbs.
A = the area included by the median line of the wall of the section in sq.in.
t = the total wall thickness in in.
S = the developed length of the median line in in.
L = the free length of the specimen in in.
α = the angle of twist in radians

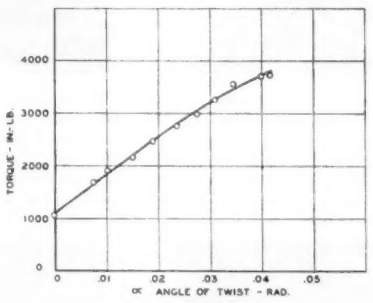

FIG. 6. Typical torsion torque-twist diagram.

The average values obtained in the tests are:

F_{su} = 1,116 lbs. per sq.in.

G_{ap} = 85,666 lbs. per sq.in.

It is known that the best arrangement for plywood to carry torsion is that in which the grain subtends an angle of approximately 45° with the plane of the torque. On the other hand, if balsa wood alone is tested in shear it fails under small loads. It was expected, therefore, that in the torsion test specimens the balsa core would play little part in resisting torsion. This anticipation, however, was refuted by a group of tests in which one end of the specimen had only an internal oak plug and the other had only an external oak block. Obviously, in this test arrangement the torque had to be transmitted through the balsa core. Nevertheless, the values of the apparent failing shear stress and the apparent initial shear modulus were only 28 per cent and 15 per cent smaller, respectively, than the values obtained with the specimens of the basic group.

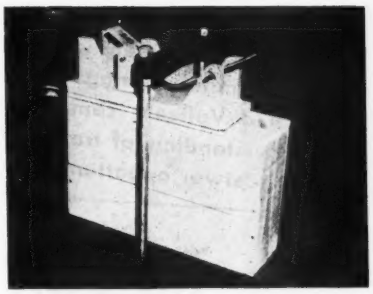

FIG. 7. Bending test setup.

It is believed that the effect of the plywood in restricting the deformations of the balsa core may have been responsible for this unexpectedly favorable result.

Bending Tests

In the third series of tests 25 specimens were tested in bending. The specimens were 15 in. long and 2 in. wide and had on both sides two 1/64-in. thick layers of spruce veneer with mutually perpendicular grain arranged at an angle of 45° with the lengthwise direction. The thickness of the balsa core between the plywood faces varied from 1/16 to ½ in.; the specific weight of the balsa wood. from 10.4 to 15.0 lbs. per cu. ft.; and the fibers of the balsa ran in the lengthwise direction.

The tests were carried out on a Fairbanks lever-type testing machine of 2,000-lb. capacity. Fig. 7 shows the test setup in which the specimen was supported by two ¼-in. diameter dowels. One of the dowels was held in its supports by two ball bearings in order to facilitate movement of the specimen when loaded. To avoid crushing of the specimen under the concentrated load at its midpoint, the force was applied through a smooth wooden block having a convex surface in contact with the specimen. Arrangement for two different distances between the dowels may be noticed in the photograph. This was necessary since the thinner specimens exhibited large deflections under loads.

Loads were measured with an error of ±1 lb. The order of magnitude of the error in the deflection readings was 10^{-4} in. Deflection readings were obtained through the use of a calibration con-

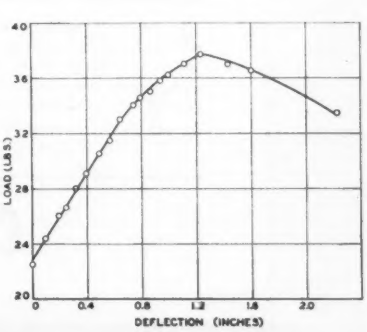

FIG. 8. Typical bending load-deflection diagram.

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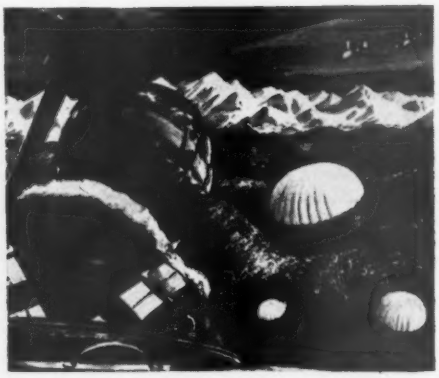
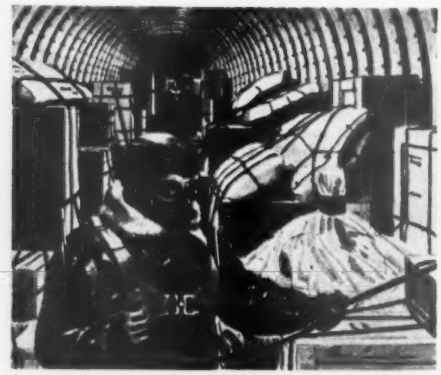


2. **The first leg** of the journey is over the steaming, foggy Assam jungles. Because there are no emergency landing fields, some of the planes have crashed. But most of the men who bail out eventually plod their way to safety, aided by rescue pilots, who drop written instructions, food, and medical supplies by parachute.

3. **Day and night,** the heavily loaded Liberator Express transport planes streak toward "The Hump." Shuttling across a tumbled mass of uncharted mountains, they dodge peaks that rise 20,000 feet. Icing is an ever-present hazard. Flying unarmed, the cargo planes are often attacked by Jap fighter planes. *Still the freight goes through!*



4. **This slender aerial life line** over "The Hump" is now the *only* channel by which Allied war equipment gets into China. Around the clock, in monsoon season and out, our flyers carry a constant stream of gasoline, bombs, jeeps, ammunition, artillery, small arms, clothing, aircraft engines and spare parts.

CONSOLIDATED VULTEE

5, many of our India-China flyers have been awarded decorations—and they've earned them! No one pretends that the supplies being flown in are sufficient to fully equip the Chinese. But the same ingenuity and courage that can conquer the lofty Himalayas will eventually open up new channels of transportation so that today's trickle of supplies will swell to an avalanche.

6. After the war, when all forms of transportation must work together to rebuild the peacetime world, the plane will continue to play its part, along with the truck, the train, and the ship. But the plane will have a second, and even greater, responsibility to fulfill: *that of helping to enforce the peace in this 60-hour-wide world.*

In short, a permanent postwar Air Force can be one of America's soundest investments in the interests of a lasting peace.

Quick Facts for Air-Minded Readers

Preview of the future—Last year, 6% of the dollar volume of all imports to the U. S. came by air—a total of 4,000,000 pounds.

Many of the air cargoes included mica, quartz crystals, industrial diamonds, and rare drugs, without which the production of vital war materials could not have continued.

Saving American lives—Litters for 8 wounded men can be fitted into the bomb bay of a Liberator bomber. The Army has already flown out several hundred thousand casualties from combat areas to hospitals.

9 tons per month—The Air Service Command reports that for every Air Force pilot based overseas, it sends out an average of 9 tons of aviation supplies monthly.

This does not include food and other items which are handled by the Quartermaster Corps.

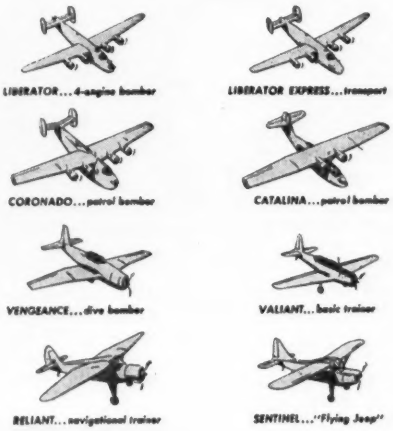
An airline is born—In order to expedite the flow of military personnel and equipment to the South Pacific, Consolidated Vultee operates a daily air-transport service known as Consairway.

A Liberator Express recently chalked up Consairway's 1000th transpacific flight.

Consolidated Vultee is the largest builder of airplanes in the world.

No spot on earth is more than 60 hours' flying time from your local airport

From "Flying Jeeps" to Leviathans of the air — *The planes shown below were all designed and developed by Consolidated Vultee. When peace comes, the company will be in a position to provide the postwar equivalent of such planes, from small, privately owned "air flivvers" to huge, transoceanic cargo-and-passenger planes.*



AIRCRAFT

San Diego, Calif. · Vultee Field, Calif. · Fairfield, Calif. · Tucson, Ariz. · Fort Worth, Texas · New Orleans, La. · Nashville, Tenn. · Louisville, Ky. · Wayne, Mich. · Dearborn, Mich. · Allentown, Pa. · Elizabeth City, N. C. · Miami, Fla.

Member, Aircraft War Production Council

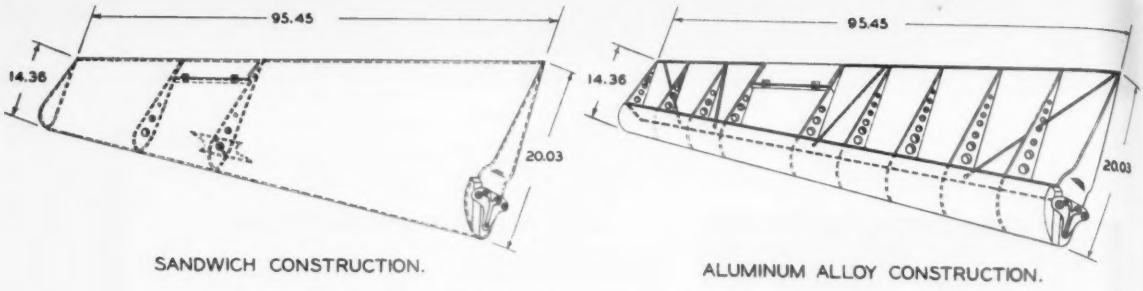


FIG. 9. Comparison of aluminum-alloy and sandwich ailerons.

stant correlating deflections to the revolutions of the loading wheel of the testing machine.

It was observed that after the maximum load had been reached the specimen continued to hold and exhibited extremely large deflections before actual rupture occurred. Practically all specimens failed through fracture of the fibers on the tension side at the middle of the specimen. Definite anticlastic curvature of the specimens was noticed in all the tests.

A typical load-deflection diagram is shown in Fig. 8. The modulus of rupture F_b is calculated from the formula

$$F_b = M_{max}.c/I$$

the apparent modulus of elasticity in bending from the formula

$$E_{bap} = PL^3/(48I\delta)$$

where

$$I = bt^3/12$$

and

$M_{max.}$ = the maximum bending moment in in.lbs.

P/δ = the slope of the tangent to the initial portion of the load-deflection curve in lbs. per in.

b = the width of the specimen in in.

t = the thickness of the specimen in in.

c = one-half the thickness of the specimen in in.

L = the distance between supports in in.

The average modulus of rupture was

$$F_b = 5{,}815 \text{ lbs. per sq.in.}$$

the average apparent initial modulus of elasticity in bending

$$E_{bap} = 472{,}000 \text{ lbs. per sq.in.}$$

No systematic variation of these values with thickness or density of the balsa wood core was observed.

Comparison with Aluminum Alloy

The comparison of the merits of a material by means of a strength to weight ratio based on some arbitrarily chosen formula is misleading. The actual value of a structure depends upon its behavior under many different kinds of loading, as well as upon considerations of design, manufacture, availability, price, etc. It is not intended, therefore, to establish a definite rating for the sandwich construction in the comparison that follows, but rather to give an indication of its advantages or disadvantages regarding the particular types of loading investigated in the experiments just described.

Since design considerations do not restrict the thickness of the skin of a monocoque, all comparison will be based upon the assumption of a thickness ratio of aluminum to sandwich skin corresponding to an equal weight of the two. With an average value of 16 lbs. per cu.ft. for the sandwich skin and 172 lbs. per cu.ft. for aluminum alloys, the thickness of the latter must be 0.093 times the thickness of the former. If the thickness of the sandwich skin is assumed to be $^5/_{16}$ in., that of the aluminum skin must be 0.029 in.

The comparison of the tensile properties is straightforward. A strip of sandwich skin 1 in. wide and $^5/_{16}$ in. thick carries $(^5/_{16}) \times 3{,}500 = 1{,}092$ lbs. A strip of 24 ST aluminum-alloy skin 1 in. wide and 0.029 in. thick fails under $0.029 \times 62{,}000 = 1{,}800$ lbs. Obviously, 24 ST aluminum alloy is better for this kind of loading than is the type of sandwich construction investigated. The suitability of the sandwich system can be improved, however, through the use of spruce veneers with the grain arranged parallel to the direction of tension.

A similar consideration of the shearing strength as established in the torsion tests gives the following results. The sandwich strip fails under $(^5/_{16})$ 1,116 = 349 lbs. With an ultimate shear stress of 37,000 lbs. per sq.in. the 24 ST aluminum-alloy strip carries $0.029 \times 37{,}000 = 1{,}070$ lbs. Thus, aluminum alloys appear to be preferable in this case of loading as in the preceding one. The conclusion is not correct, however, since such a thin gauge aluminum-alloy sheet buckles long before the ultimate shear stress is reached, unless it is reinforced, while all the twisted sandwich cylinders showed a clear tension break across the diagonal grain. If, however, the aluminum-alloy cylinder is reinforced, the weight of the reinforcing elements must be accounted for in the comparison. For a circular cylinder of 1.8-in. radius, 9-in. length, and 0.029-in. wall thickness, Donnell's formula[5] gives a critical stress in torsion $f_{cr} = 21{,}000$ lbs. per sq.in. The actual critical stress is about two-thirds of the theoretical—that is, 14,000 lbs. per sq. in. The use of this value in the place of 37,000 lbs. per sq.in. results in a total failing load of 405 lbs. This is still slightly higher than the load carried by the sandwich wall, but a radius of curvature of 1.8 in. is exceptionally small in aircraft structures. With increasing radius, however, the buckling stress of the aluminum-alloy cylinder decreases and the advantage of the stable sandwich system becomes pronounced.

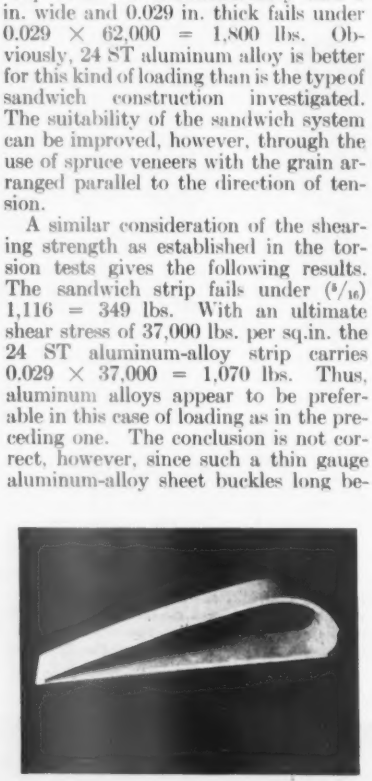


FIG. 10. Sandwich aileron shell section.

The section modulus of a strip 1 in. wide and $^5/_{16}$ in. thick is 0.0162 cu.in. The bending moment carried by such a strip of sandwich material is $0.0162 \times 5{,}815 = 94$ in.lbs. The section modulus of a strip 1 in. wide and 0.029 in. thick is 0.00014 cu.in. If the 24 ST aluminum-alloy strip is assumed to have a modulus of rupture in bending of 100,000 lbs. per sq.in., the bending moment carried by it becomes $0.00014 \times 100{,}000 = 14$ in.lbs. From these data the advantage of the sandwich system is obvious for this kind of loading.

In conclusion it may be stated that from the strength-weight standpoint the advantages of the sandwich skin lie in its local bending strength and rigidity and in its stability which makes the danger of buckling remote. Preliminary tests of specimens having aluminum-alloy faces and a balsa or a synthetic core show even more favorable results, but no report on these can be made available at present.

DESIGN AND MANUFACTURE

Fig. 9 shows an aileron manufactured according to current practice in aluminum-alloy airplane construction, and the Skydyne sandwich aileron designed to replace it. Fig. 10 is a photograph of the cross section of the sandwich aileron and illustrates the arrangement of the balance lead. The original aileron weighed 23.75 lbs. including 11.75 lbs. of balance lead; the sandwich aileron weighed 22 lbs., including 12 lbs. of

POLYETHYLENE

-A Carbide Production Achievement for the Navy

Important New Plastic Has Many Unusual Properties

A little over two years ago, the U. S. Navy learned that the Carbide and Carbon Chemicals Corporation in collaboration with an associate company, The Linde Air Products Company, had developed a high pressure synthesis of a new material, Polyethylene, and it was found that this material was exactly suited to meet the Navy's requirements of an insulation for coaxial cable used in radar equipment.

At the Navy's request, these two companies, working together but entirely independent of anyone else, designed in their own Engineering Department, and built with their own Construction Organization a plant to produce polyethylene by a process different from any other commercial polyethylene process.

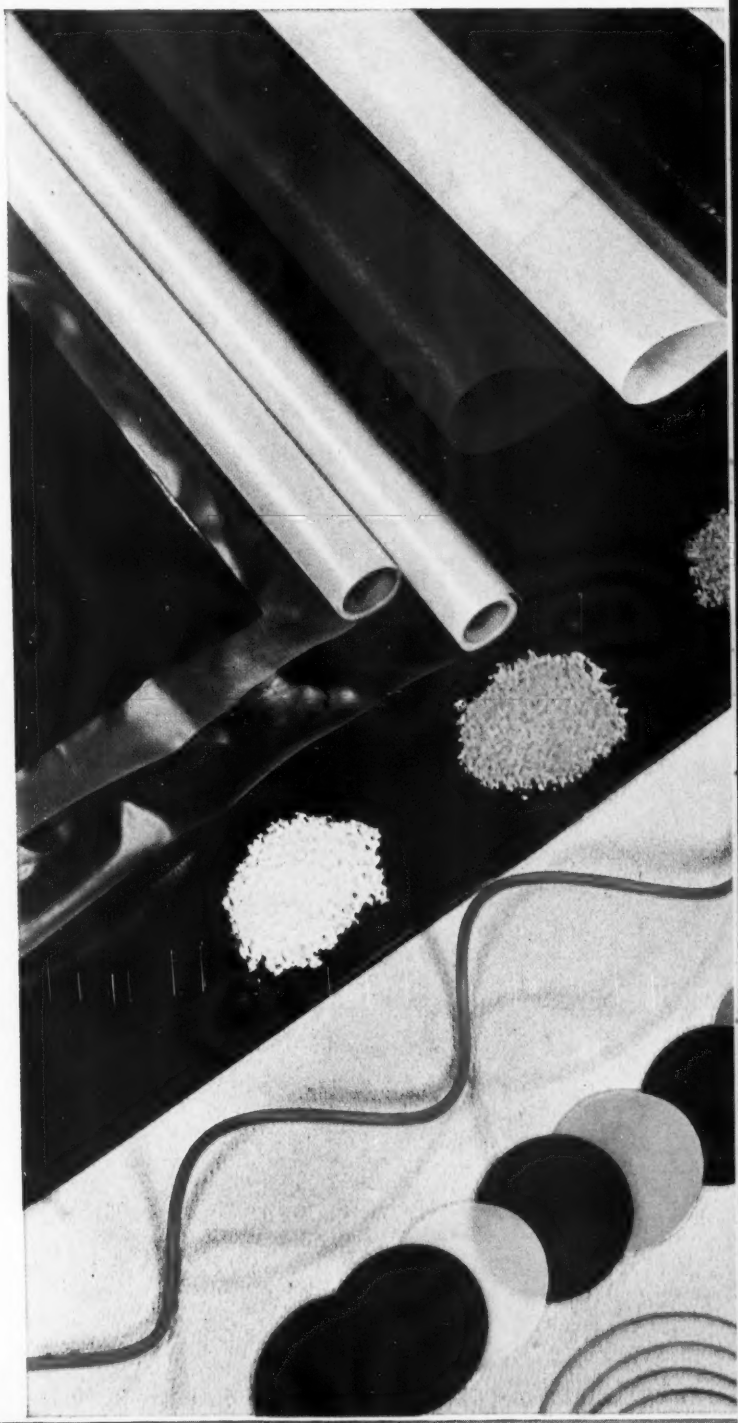
Within thirteen months from the date the project was authorized, this plant was producing at 180 per cent of rated capacity.

At the conclusion of the first full year of production the Navy Department told the plant:

"One year ago your plant commenced the production of polyethylene, a component of radio cable essential to the efficiency of electronic communications units and, therefore, vital to the success of naval operations. Production for the year has equalled 240 per cent of the rated output for the facilities. Everyone engaged in developing the product, planning, engineering, and managing the plant, and each of you engaged in producing polyethylene may be justly proud of a valuable contribution to the war effort."

Today, approximately two years after Carbide was given the assignment, this plant is producing polyethylene at 600 per cent of rated capacity and is providing the Navy's requirements of this material for use in coaxial cable.

(This advertisement has been reviewed and approved by the U. S. Navy Department)



Plastics Division

CARBIDE AND CARBON CHEMICALS CORPORATION

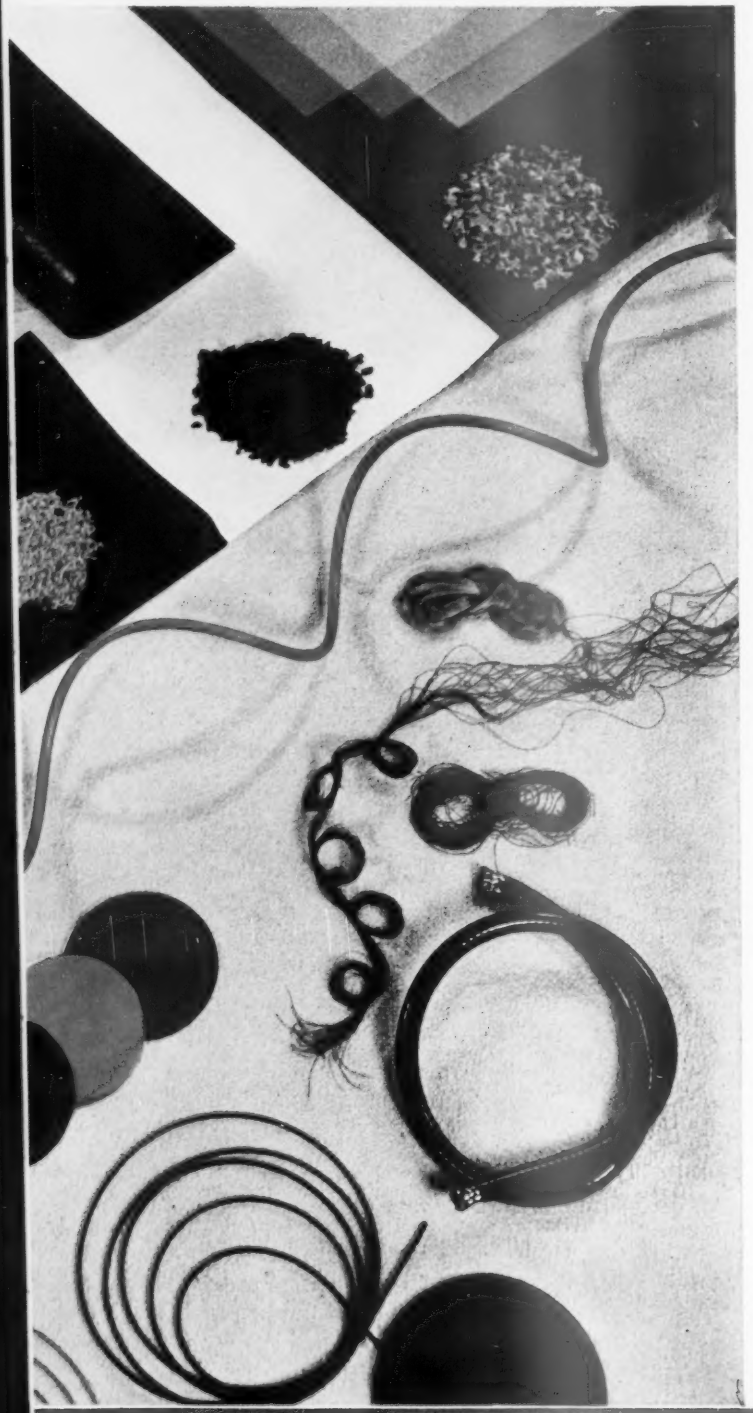
Unit of Union Carbide and Carbon Corporation

UCC

30 EAST 42nd STREET, NEW YORK 17, N.Y.

POLYETHYLENE

—A Carbide Production Achievement for the Navy



The Important New Plastic!

Polyethylene resins have the most favorable electrical characteristics of any plastic material for use in this electronic application. In addition, this new plastic material has many other exceptional characteristics, which suggest widespread application in many different fields. Polyethylene plastics are tough and impact-resistant. They are inherently flexible and extensible. They have an extremely low water vapor transmission coefficient and will absorb an unusually low percentage of water. Their chemical resistance is outstanding. Polyethylene is one of the lightest plastics, so light that it will float in water. It maintains its valuable properties over a wide range of temperature. It remains usable at temperatures lower than 90 degrees below zero, Fahrenheit, and is sufficiently rigid for use in temperatures up to 230 deg. F.

Polyethylene is colorless and translucent as originally manufactured but it can be formulated to produce colored products of exceptionally high lustre. These products can be fabricated by standard processes on existing plastics equipment.

Molded and extruded products, cloth coatings, flexible sheeting and film, and monofilaments are among the polyethylene plastic products which will be available in the future.

Polyethylene plastics are now restricted to applications covered by WPB Limitation Order No. 348. Technical data and samples for controlled end uses can be obtained by manufacturers with plastic-processing equipment by writing Plastics Division, Carbide and Carbon Chemicals Corporation.

(This advertisement has been reviewed and approved by the U. S. Navy Department)

Plastics Division

CARBIDE AND CARBON CHEMICALS CORPORATION

Unit of Union Carbide and Carbon Corporation

UCC

30 EAST 42nd STREET, NEW YORK 17, N.Y.

In the tense hours of every American advance, "roll out the barrel" means **paint.** Paint out the enemy's targets—our guns . . . trucks . . . tanks . . . planes . . . runways . . . whole villages and towns!

This new kind of landscape painting isn't careful or sparing. You're betting paint against American lives. You spray it on, hose it on, dump it on.

At the "University of Petroleum," Shell's research laboratories, scientists combed through the vast number of products, by-products, and "waste products" of refining, looking for "the makings" of camouflage paint.

They didn't find it ready-made—they went to work. Now, from a refinery by-product, Shell is producing petroleum resins, by the thousands of barrels, for camouflage.

Thus—one more outstanding contribution to America's war effort from Shell.

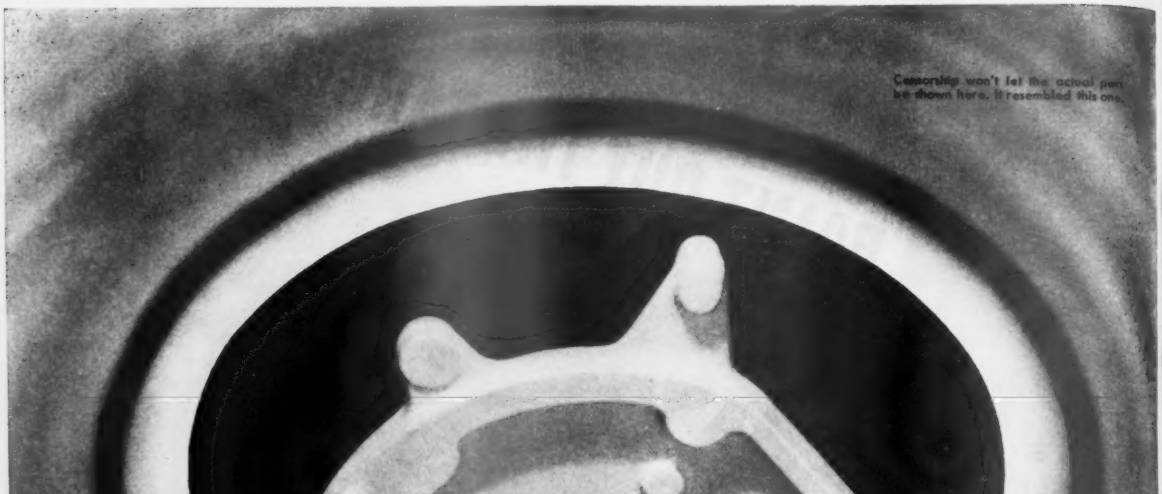
Shell was first, too, to supply American military aviation with a super fuel—100 octane gasoline—giving our planes new speed, flying range, and tactical advantage. Later Shell discoveries vastly increased both the power and production of aviation gasoline.

Today, more Shell 100 octane aviation fuel is supplied to aircraft engine manufacturers, for critical test and run-in purposes, than any other brand.

Farsighted airport operators will find Shell's wartime popularity a profitable peacetime asset.

SHELL

FINER FUELS FOR THE AGE OF FLIGHT



The boss was a troublemaker, until...

Examination in Alcoa's stress-analysis laboratory disclosed that the boss was a "stress concentrator". Having determined that here was the source of trouble which showed up in service, the part was redesigned. The fault was corrected.

Bosses, ribs, and the like, have a definite purpose. But when they are found to cause excessive stress concentrations, Alcoa's research men seek some way of distributing the stresses more uniformly. Our engineers may recommend a better blending of the sections, more metal here, less there. Then new parts, incorporating those suggestions, are given a stress analysis. Checked "O.K.", the piece is ready for test.

With research like this provided by Aluminum Company of America, manufacturers have been better able to get into production fast. Fighting equipment on land, in the air and on the sea is more dependable, because vital Alcoa Aluminum and magnesium parts were thus proved dependable.

Perhaps you have not been able to get materials for certain "civilian" uses. Winning the war comes first. But aluminum is now being used for other-than-war purposes, as the manpower situation permits. Our representatives will be glad to discuss the availability of aluminum with you. Write ALUMINUM COMPANY OF AMERICA, 2142 Gulf Bldg., Pittsburgh 19, Pa.

ALCOA ALUMINUM

balance lead. The simplicity of the design of, and the small number of parts in, the sandwich aileron are to be noted. The next few photographs illustrate different phases of the production procedure as developed for this particular job.

Manufacture of the aileron begins with cutting balsa wood on the band saw or rip saw and edge-gluing it to panels of the required size. A panel is then bent to the shape of the leading edge. The balance lead is inserted and fixed temporarily by gluing it in place with rubber cement. A phenolic glue is applied by a spray gun to the surfaces of the leading-edge piece. Two other panels are planed to a tapering thickness, sent through the glue-spread machine, and edge-glued to the leading edge piece.

Two panels of mahogany plywood are prepared for gluing to the inner and outer surfaces, respectively, of the balsa wood core. Each panel consists of two veneers $^1/_{64}$ in. thick. The grain in one veneer is perpendicular to that in the other both being arranged at 45° to the spanwise direction.

The assembled plywood and balsa core are placed in a hard wood mold that is reinforced with heavy steel channels (Fig. 11). A rubber bag is inserted into the assembly, and an internal air pressure of about 40 lbs. per sq.in. is applied. A heating pad is attached to the surface of the rubber bag, and the hard wood mold is provided with metal heating elements. The assembly is kept in the mold for 10 min. at a temperature of about 220°F., during which the gluing operation is completed.

The edges of the glued product are usually not quite satisfactory, therefore they are trimmed about 1 in. to final size in a pattern. Fig. 12 is a photograph of the completed aileron shell.

Fig. 13 shows all the reinforcing elements needed for the aileron. They are the prefabricated ribs that close the two ends of the aileron and the tab cutout, the reinforcements at the points of application of concentrated loads, and the trailing edge insert. After the application of phenolic glue to the surfaces of these elements, they are inserted in the aileron shell, and the entire assembly is placed into an assembly jig that locates the elements precisely. The assembly jig also serves as a press, its upper part being tightened to the lower one through eight bolts by which means pressure is exerted upon the glue lines of the reinforcing elements of the aileron. The assembly jig press is shown closed in Fig. 14 and open in Fig. 15. Heat is applied to the glue lines through metal strips provided in the jig. A temperature of about 300°F. is needed in this operation since the heat is supplied to the glue line from only one side. The trailing-edge insert is held firmly in place by a number of horizontally arranged screws which are clearly visible in the photographs.

When the aileron is taken out of the assembly jig press a normal dipping operation is undertaken in order to seal

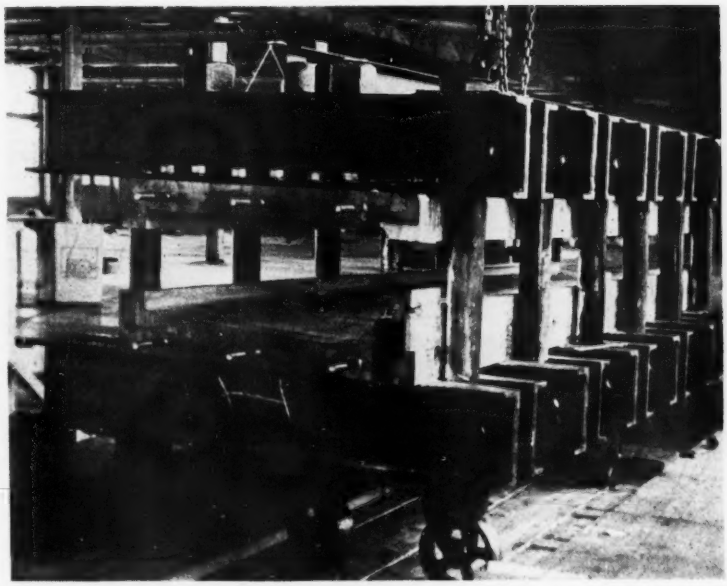


FIG. 11. Aileron inside pressure mold open.

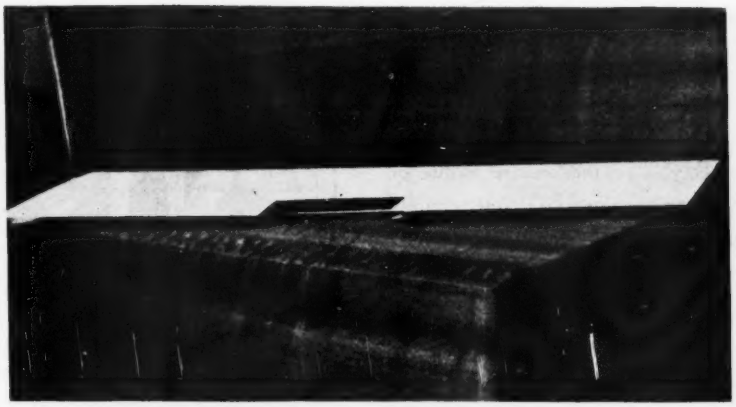


FIG. 12. Aileron shell.

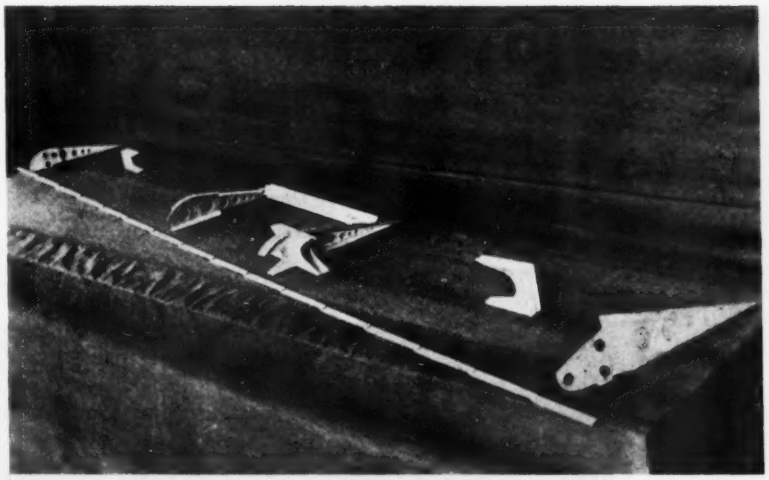
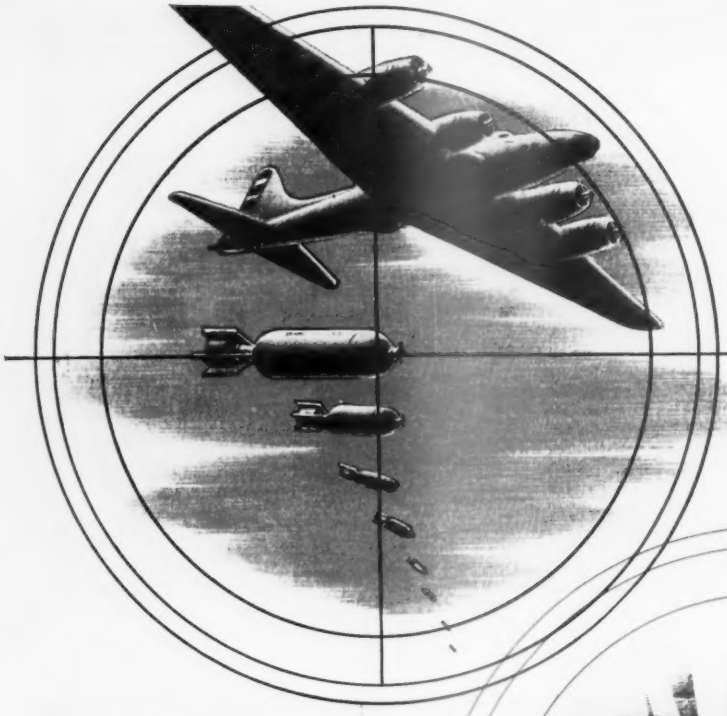


FIG. 13. All components of aileron.



ACCURACY TODAY

TODAY... the creative ability of Honeywell engineers is devoted entirely to providing war winning equipment, and has produced such outstanding contributions as the Electronic Autopilot, the Electronic Turbo Supercharger Control System and many others . . .

TOMORROW, when Victory is won, this same creative engineering will be ready for peacetime aeronautical problems. In the Minneapolis-Honeywell hangar and test laboratories one of the largest of its type ever built — are being conducted tests and performance records that will lead to bigger and better things for peacetime aviation. Yes, Honeywell is in the aeronautical control field to stay. Minneapolis-Honeywell Regulator Company, 2700 Fourth Ave. S., Minneapolis 8, Minnesota.

SAFETY TOMORROW

MINNEAPOLIS Honeywell CONTROL SYSTEMS

Makers of the famous M-H Electronic Autopilot, used on AAF four-engined bombers

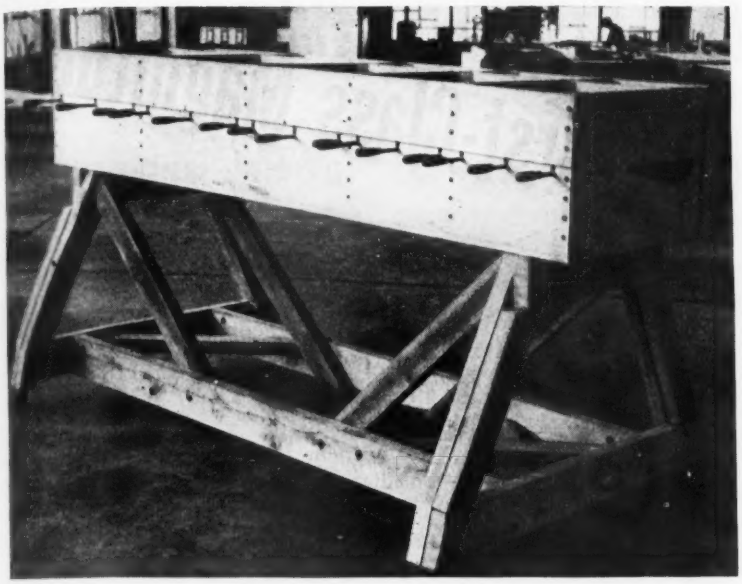


FIG. 14. Aileron assembly jig press closed.

it. After the few external attachments have been screwed on and a finish coat of enamel is applied, the aileron is ready for use.

The manufacturing procedure just described is a typical example and applies in all detail to the particular aileron only. It can be modified to suit special demands, and various improvements on it are possible. The use of molds cast in plastics and heating by high-frequency electric current may be mentioned as examples.

Another airplane part built according to the sandwich principle is shown in Fig. 16. It is a helicopter boom, or tail cone, molded all in one piece and weighing 25 lbs. The overall length of the boom is 175 in.; its diameter at the front end, 20 in.; at the rear end, 6 in. The required ultimate bending moment at the front end was 84,000 in.lbs., the permissible total deflection at the rear end $1^1/_2$ in. The manufacturing procedure used in this case differed from the one just described inasmuch as the internal rubber bag was replaced by an external rubber bag from which the air was sucked out by an ejector. An interesting detail of the design is the application of an aluminum-alloy reinforcing collar to the front end of the boom. It is cycle-welded to the wood and serves the purpose of reducing the bearing pressure and the shear stress in the wood at the points where high concentrated loads are introduced into the tail cone through the attaching bolts.

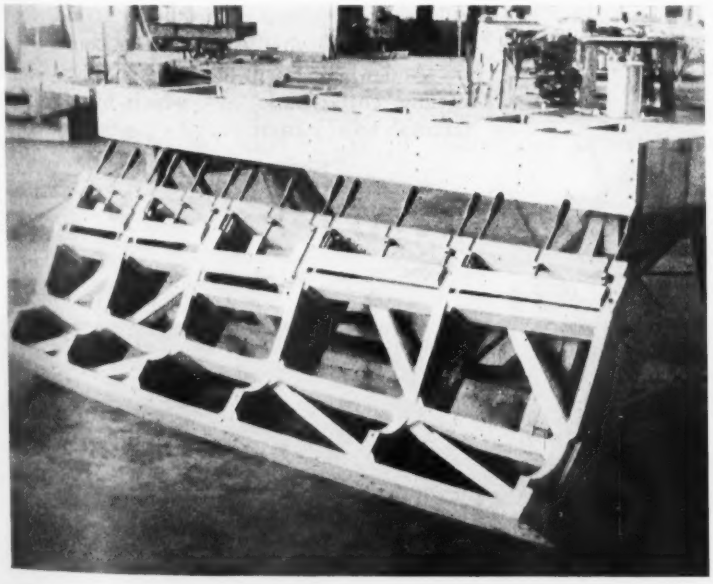


FIG. 15. Aileron assembly jig press open.

CONCLUSIONS

It was shown in the section on the history of the sandwich construction that the incentive for its development was given by the desire to build a true monocoque airplane. The true monocoque has long been recognized as the ideal in aircraft construction because of its excellent space utilization, its suitability for streamlining, and its inherent smoothness of surface.

The same properties are also present in the modern aluminum-alloy semimonocoques, but they are achieved at the cost of great complexity of the structure caused by the longitudinal and transverse reinforcing elements necessary for the stabilization of the thin aluminum-alloy skin. Because of the great number of small reinforcing elements, the complexity of their fitting, and the labor involved in their riveting, aluminum-alloy semimonocoques are inherently expensive. The cost can be reduced only in mass production, in which, however, the expense of tooling up is great.

The armed forces of the world are willing to pay the cost of this expensive production, but the private owner will certainly look for a more reasonable design. The aluminum-alloy semimonocoque does not have a good chance, therefore, in the postwar light plane field, particularly since the numbers of each type produced are likely to be small and, thus, no advantage could be gained from mass production.

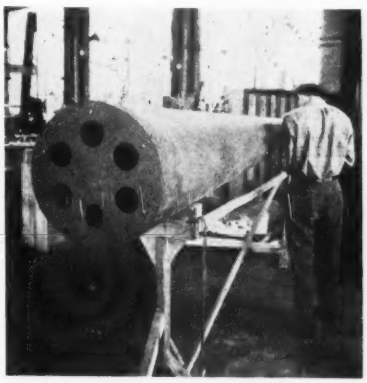


FIG. 16. Helicopter boom.

The drawbacks of aluminum-alloy semimonocoque construction are not found in sandwich construction. It combines the advantages of monocoque construction with inexpensiveness in manufacture. It is well suited to small series production, since the small number of molds and jigs needed can be built of wood at a low cost.

The structural strength and efficiency of the sandwich construction has advanced rapidly in recent years. Phen-

(*Continued on page 63*)

Then he said to himself

"A War Measure of First-Class Magnitude"

WHEN the standing of India was occupying the attention of Washington, Mohandas Karamchand Gandhi wrote to the India League of America:

> "I want you to look upon the immediate recognition of India's independence as a war measure of first-class magnitude."

For a man so definitely non-Hollywood in dress or words "FIRST-CLASS MAGNITUDE" amounts to a cataclysmic pronunciamento.

Again it shows that one who is fired by a great idea automatically adds emphasis to enthusiasm! And *that* is an important business measure.

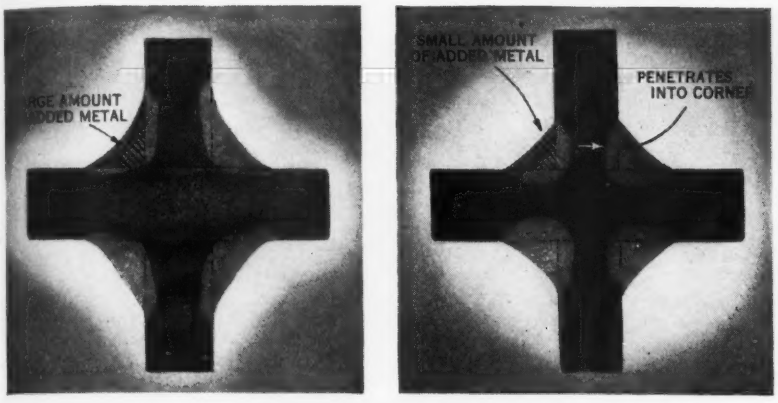
You saw it well illustrated when war conversion was hurled at manufacturers . . . and when "impossible" schedules were handed them.

Men were far from enthusiastic. Remember?

But viewed in the light of subsequent experience, those quotas for air, land and sea weapons today seem modest. All because aroused men quickly found out first-hand what Arc Welding could do. And when it did the job well, they became enthusiastic . . . which brings triumph to any front.

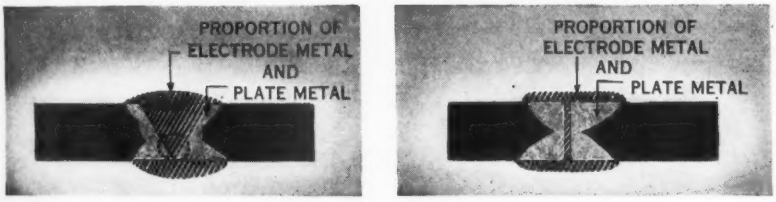
"A War Measure of First-Class Magnitude"...he says

CONVENTIONAL WELDING **"FLEET-WELDING"**



TYPICAL FILLET WELDS

STRENGTH:	Stronger than plate	STRENGTH:	Stronger than plate
SPEED:	5" per min.	SPEED:	12" per min.
COST:	100%	COST:	42%



TYPICAL BUTT WELDS

STRENGTH:	Stronger than plate	STRENGTH:	Stronger than plate
SPEED:	2" per min.	SPEED:	9" per min.
COST:	100%	COST:	25%

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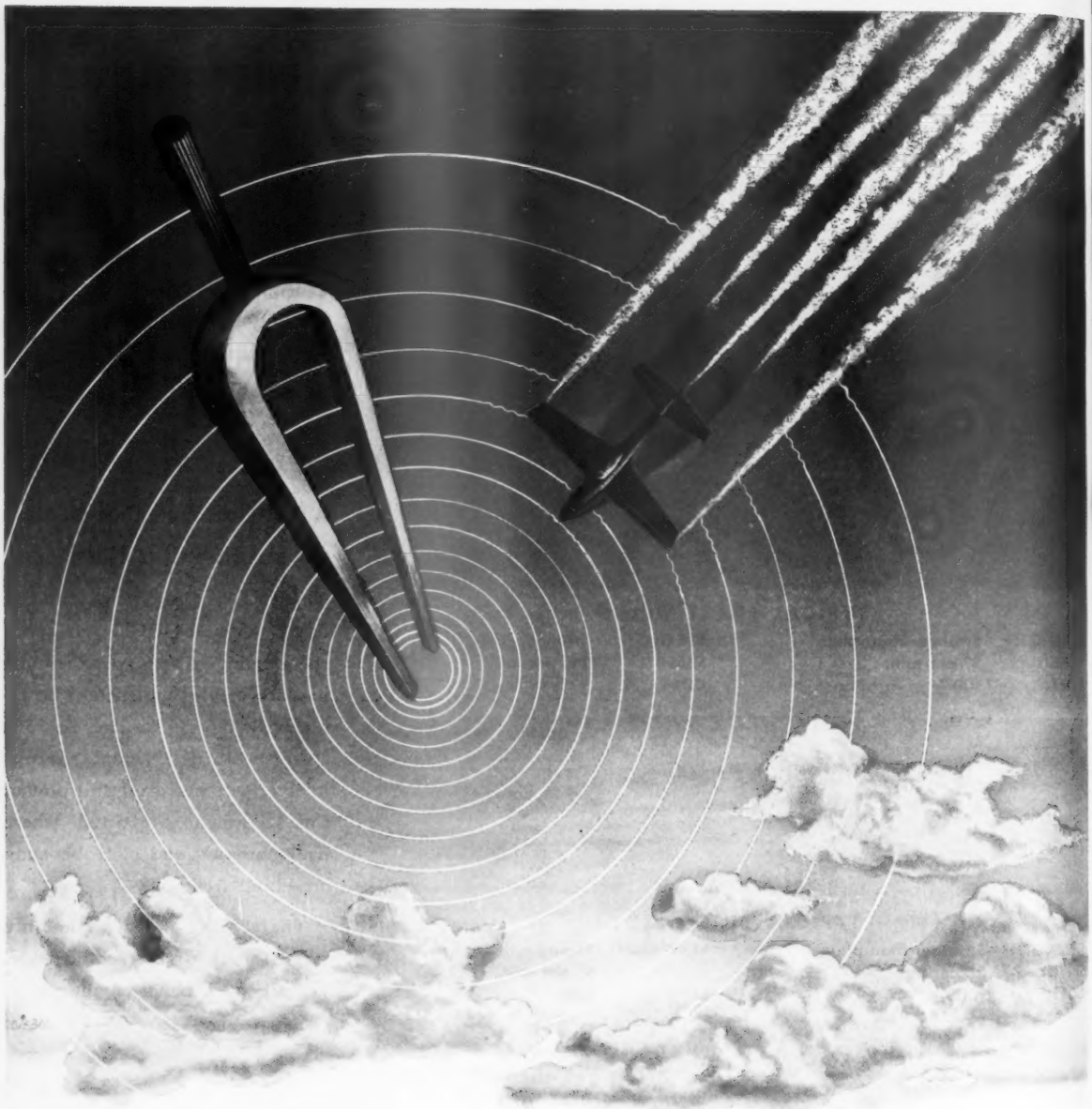

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KOLLSMAN AIRCRAFT INSTRUMENTS

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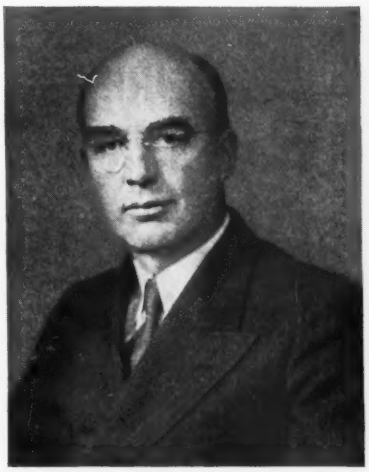
Suggestions for Furthering Private Flying

J. H. GEISSE*

Civil Aeronautics Administration



Introduction

At a meeting held in Detroit in 1935 I delivered a paper on the subject "Air Transportation Equipment for the Private Owner." At that time I expressed my belief that the airplane of that day could not possibly be sold in large quantities and gave reasons for my belief. At that time and on later similar occasions I was severely criticized for even mentioning the deficiencies of the private airplane. I told of these deficiencies in the hopes that they would be remedied and a substantial and continually expanding market would be created. To me the most encouraging aspect of postwar private flying is the indication that this is going to be done.

Private Ownership

Having personal knowledge of many people who purchased airplanes only to keep them for a short time, I decided to find out, in 1940, just how long the average person did maintain private airplane ownership. For this study I used the Airplane Registration list published annually by the Aeronautical Chamber of Commerce of America for the years 1930 to 1939, inclusive. The results of this study are shown in Fig. 1, from which it will be observed that approximately one-third of all the owners continued ownership for 1 year or less and another 22 per cent continued on owning for 2 years. By extrapolating the curve from 7 to 30 years on the assumption that this would be the longest period of ownership for any owner, the mean period of ownership for all owners is indicated as less than 4 years. The study indicated that in the years of 1931 to 1936, inclusive, there were approximately 15,000 new owners recorded with a net gain in the total number of owners in this period of 200.

In the same year I made a study of our records of student permits and new pilot certificates issued in each year from 1933 to 1938, inclusive. The results are shown in Table 1, from which it will be noted that the percentage of students who continued on to secure pilot certificates stayed at around 15 per cent.

To determine why the attrition rate was so high, I prepared questionnaires that were sent to a large number of former owners and individuals who had taken out student permits but had given up flying before receiving pilots' certificates. The results from the former are shown in Table 2 and 3 and those of the latter in Table 4.

It should be noted in Table 2 that 77 per cent of the owners purchased with the initial intention of continuing private airplane ownership. Particular attention should also be paid to the fact that 27.7 per cent believed that too much consideration had been paid to high speed and too little consideration to low speed, as against 11 per cent who held the opposite view. It should also be noted that, excluding those who purchased their airplanes to build up time for commercial certificates, approximately 50 per cent of the owners purchased their airplane for local flying.

The reasons given for discontinuance of ownership are shown in Table 3. It should be noted that 30 per cent indicated that the expense was greater than anticipated. The question was so worded because it was assumed that they would not have given up flying because of an expense that they had anticipated when they made their purchase. Adding to these the 19.7 per cent who gave up ownership because of a change in financial status, a total of 50 per cent gave up ownership because of reasons of cost. However, it is not at all unlikely that a large percentage of these would have found ways of maintaining ownership if they had found ownership sufficiently attractive to give up other things to retain such ownership. Since it is the ratio of value received to cost which determines sales, the first two items are not on the same side of the sales equation as the other items, and this distinction should be kept in mind in considering these figures.

The results of the student pilot survey shown in Table 4 are in substantial agreement with the results of the past owner survey. Again it should be noted that over 50 per cent gave up flying because of financial reasons and that, excluding the 28 per cent who expected to fly commercially, 50 per cent wanted to fly just for the pleasure of flying.

Effect of Hazards of Flying

In considering the results of these surveys it should be remembered that these surveys covered only individuals who

Presented at the National Light Aircraft Meeting, I.A.S., Detroit, April 27–28, 1944.

* Consultant, Research Section.

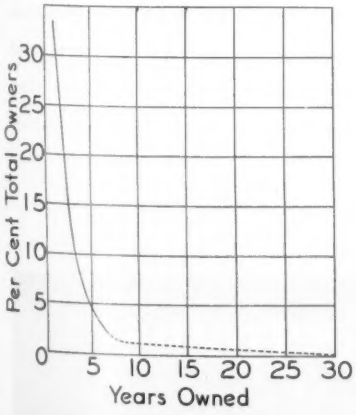


Fig. 1. Airplane ownership.

Table 1
Student and Pilot Certificates

	1933	1934	1935	1936	1937	1938
Student certificates issued in year	12,752	11,994	14,572	17,675	21,770	18,561*
New pilot certificates issued in year	1,798	1,799	2,250	2,610	3,441	2,893
Ratio new pilots to students—%	14.0	16.5	15.5	14.8	15.8	15.5
Pilot certificates current as of December, 1931	13,960	13,949	14,805	15,952	17,681	19,978*
Increase during year		−11	856	1,147	1,729	2,297
Lapses during year		1,810	1,394	1,463	1,712	596
Ratio lapses to total as of January 1—%		13.0	10.0	9.8	10.7	3.4

* 3,005 solo certificates deducted from number of new pilot certificates and added to student certificates.

More air-borne cargo can be moved

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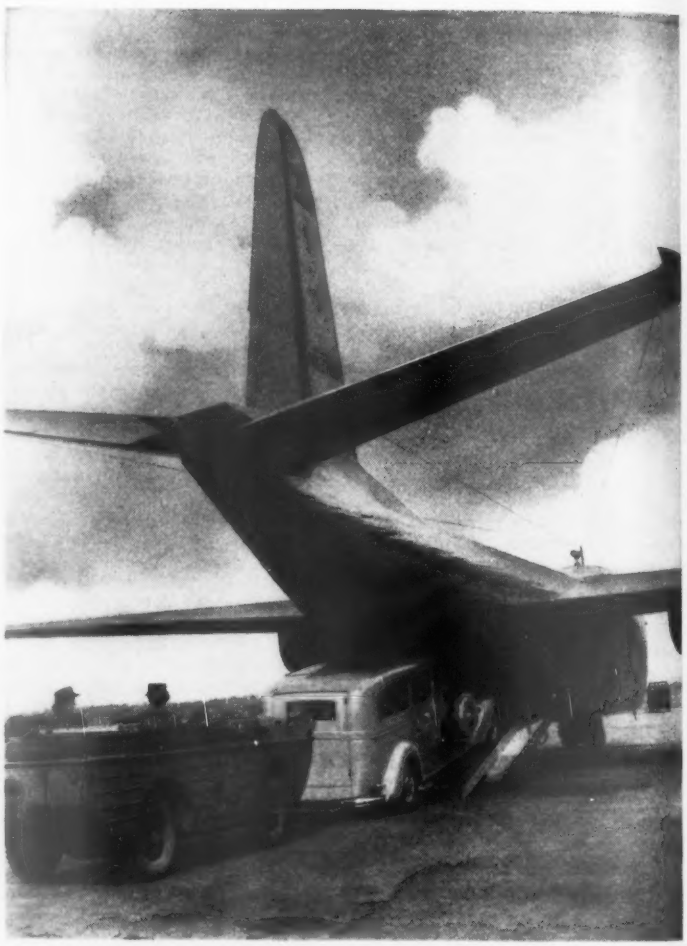

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had at one time taken up private flying and, hence, they do not necessarily reflect the reasons why the majority of our population have not taken to this activity. The fact that only a small percentage of the students indicated that hazard was a factor in giving up flying and that the number of private owners who gave this reason was too small to be recorded does not indicate that this is an unimportant item in sales resistance. Furthermore, although the hazards of flying did not appear directly in these surveys as a reason for discontinuance, they did indirectly, and in large measure in the item of cost.

TABLE 2
Private Owner Survey

Reasons for Purchase:	
Local flying	42.5%
Cross-country flying	34.8%
Transportation for business	8.0%
To build up time for Commercial Certificate	14.7%
Number holding pilot certificates during ownership	169
Number holding pilot certificates at time of questionnaire	66
Plane purchased for permanent use	77%
Plane purchased for temporary use	23%

Airplane Characteristics Stressed Too Much or Too Little by the Designer:

	Too Little Consideration	Too Much Consideration
High speed	8.4	22.0
Low speed	5.7	2.2
Comfort	9.0	2.3
Safety and ease of control	5.0	5.5
Miscellaneous	26.0	12.9
	54.1	45.9

TABLE 3
Private Owner Survey

Reasons for Discontinuance:	
Expense greater than anticipated	30.3%
Change in financial status	19.7
Too much time to and from airports	8.9
Not as useful as expected	6.8
Desired flying time procured	5.1
Change in family status	5.0
Too much regulation	4.2
Pleasure less than anticipated	3.0
Family objections	2.5
Too much time to keep in practice	2.4
Miscellaneous	12.1
	100.0%

Insurance Rates

The effect of the hazards of flying on the cost thereof is well shown in Table 5, particularly for the average private owner who uses his airplane about 100 hours per year. These hazards are directly reflected in the cost of insurance. The reason for these high insurance rates may be found in Table 6. During the 9 years covered by these statistics an average of 4.8 per cent of the registered airplanes were destroyed by accident each year. An additional 4.4 per cent were badly damaged and 9.5 per cent were sufficiently damaged to require the replacement of major parts. Further evidence that the insurance premium for hull insurance is not out of line with experience is found in the records of the airplane insurance companies from 1938 to 1942, which show a loss ratio of 54.9 per cent on this class of insurance, a loss ratio that is not unusual in the casualty insurance business. However the loss ratios on the other forms of insurance are unusually low as shown in Table 7. In this figure I have shown the present rates, the present loss ratios, and rates adjusted to 54.9 per cent loss ratio in each case. I have also shown the automobile insurance rates, which are directly comparable. No rate is shown for passenger liability for the automobile, since this risk is included in the public liability risk.

Changes in Insurance Rates

The effect of changes in insurance rates on the cost of private airplane operation is shown in Table 8 which shows the cost with the present rates, the adjusted rates, and with automobile rates. It should be noted that the reduction in cost per mile which might be accomplished for the private owner flying 100 hours per year by adjustment of the rates on the basis of present safety records would be only $0.016, whereas a reduction of $0.051 could be obtained if the safety of operation of the airplane could be made comparable to the safety of operation of the automobile. It is my personal view that it should be possible to do this—at least until the air becomes congested. To give an indication of how much we could afford to pay for such an increase in safety, I have added cost figures using the automobile rates of insurance but increasing the cost of the airplane from $2,000 to $4,000. To me it is significant that doubling the cost of the airplane and applying automobile insurance rates would still provide a lower cost of operation per mile than that shown for insurance rates adjusted to present safety records. Those who gave up private airplane ownership in the past because of cost did so because of operational cost—not initial cost.

Excessive Regulation

The hazards of flying are also indirectly responsible for two other items of sales resistance. The first is the cost in time and money to learn how to fly. The second has probably escaped attention. The extent of Federal Regulation of private flying is occasioned primarily by the hazards of this activity. In a way it might be said that we have tried to provide safety in private flying by regulation rather than by the development of the private airplane. Instead of demanding safety of the airplane in the hands of the relatively unskilled pilot, we have progressively demanded more skill and experience from the pilot and surrounded him with more restrictions on what airplanes he could fly and when he could fly them. Instead of building the airplane so that it could be safely repaired by any reasonably skilled mechanic, we have required that they be maintained and repaired only by especially qualified personnel certificated by the Government. That these regulations can have an adverse, as well as a favorable, effect upon sales is evidenced in the results of the survey of past owners. Excessive regulation was not included as a possible reason for giving up ownership in the questionnaires sent out. Nevertheless, a sufficient number of those replying inserted this item under "other reasons" to make it necessary to list this as a separate item.

TABLE 4
Results of Student Pilot Survey

Reasons for Obtaining Student Certificate:	
To permit you to fly for the pleasure of flying	37.2%
To permit you to fly commercially	28.4
To permit you to fly for pleasure transportation	13.3
To learn how to fly simply as an accomplishment	7.4
To permit you to fly for business transportation	7.2
To determine whether you desired to fly	5.5
Solely for privileges of a student certificate	1.0
	100.0%
Reasons for Not Continuing:	
Expense greater than anticipated	29.5%
Change in financial obligation or status	27.1
Too much time taken up going to and returning from airport and waiting for ship	9.0
Unsatisfactory accommodations for learning	8.3
Objections by family or others	5.0
Too much flying time required to keep in practice	4.3
Change in family status	3.6
Not as useful as expected	1.8
Flying more difficult than expected	.6
Pleasure less than anticipated	.5
Hazard greater than anticipated	.2
Other reasons	10.1
	100.0%

TABLE 5
Airplane Operation Costs (65–75 hp.—$2,000)

Hours use per year	100	200	1,000
Direct operating cost	$ 177	$ 354	$1,770
Rent	180	180	180
Depreciation	200	200	200
Hull insurance	310	310	310
Liability and property damage	148	148	148
	$1,015	$1,192	$2,608
Cost per hour	$10.15	$5.96	$2.61
Cost per mile (80 m.p.h.)	0.127	0.074	0.033

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TABLE 6. COST OF PRIVATE FLYING

Estimate of Airplane Life—Date Supplied by Civil Aeronautics Authority

	1930	1931	1932	1933	1934	1935	1936	1937	1938
Airplanes registered on Jan. 1	9,840	9,818	10,680	10,324	9,284	8,270	9,072	9,229	10,832
Airplanes produced Jan. 1–Dec. 31	2,230	1,807	667	677	853	1,079	1,637	2,289	1,823
Total	12,070	11,625	11,347	11,001	10,137	9,349	10,709	11,518	12,655
Airplanes registered Dec. 31	9,818	10,680	10,324	9,284	8,270	9,072	9,229	10,832	11,063
Airplanes retired (Total minus Dec. 31 registry)	2,252	945	1,023	1,717	1,867	277	1,480	686	1,592
Airplanes destroyed by accident	721	669	546	435	390	359	322	392	334
Airplanes requiring major overhaul due to accidents	174	237	231	213	240	322	961	857	625
Airplanes requiring major assembly due to accidents	1,169	1,323	1,199	957	884	850	437	702	794

Average yearly registration	9,705
Total produced January 1, 1930, to December 31, 1938	13,062
Total retired January 1, 1930, to December 31, 1938	11,839
Total destroyed January 1, 1930, to December 31, 1938	4,168
Retired other than by accident	7,671
Airplanes requiring major overhaul due to accidents	3,860
Airplanes requiring major assembly due to accidents	8,315
Percent registered retired per year	13.6
Percent registered destroyed per year	4.8
Percent registered retired not by destruction	8.8
Percent airplanes requiring major overhaul due to accidents	4.4
Percent airplanes requiring major assembly due to accidents	9.5
Average life, excluding destruction, years	11.3
Average life, including destruction, years	7.4

TABLE 7

Insurance Rates

	Present Rate	Loss Ratio	Adjusted Rate	Automobile Rate
Hull	$310	54.9	$310	$33
Passenger liability	68	10.0	13	0
Public liability	35	4.3	3	13
Property damage	45	7.7	6	5
	$458		$332	$51

REDUCING TRAINING TIME

An indication of what might be accomplished in the way of reducing the training time required can be found in the investigation of the training time required for the Ercoup conducted by the Research Division, Civil Aeronautics Administration. The direct result of this program was the reduction of time required for a private pilot certificate in airplanes of the Ercoup class from 35 to 25 hours and the reduction of the time required before the first solo from 8 to 5 hours. This program was carried on under extremely adverse conditions, and it is my belief that if it could be repeated under more favorable conditions a still further reduction could be justified.

What could be accomplished in the reduction of training time required for conventional airplanes by improvements in teaching methods and improvements in instrumentation and slight changes in the airplane performance no one knows. We have just recently inaugurated a research project in an effort to find out. Despite all the years that we have been teaching people to fly airplanes, to the best of my knowledge no such study has heretofore been made. The possibility that a poor pilot who is a good instructor might give better instruction than the most expert pilot who is a poor instructor has been recognized only recently by some of our largest flight schools. It was discovered in our research program on the training and selection of pilots that in many cases the instruction given by the instructor to the student in the air must have been perfectly unintelligible to the student. This was determined by recording the conversation between the instructor and the student, and the results amazed even the instructors whose instruction had been recorded. Recently, I prepared a proposed change in our method of instruction and distributed it for comments and criticisms. I was startled by the differences of opinion on how an airplane flies where there is no room for a difference of opinion.

INSTRUMENTATION

In the matter of instrumentation there has been practically no effort made to develop and provide instruments that would simplify instruction and, incidentally, would reduce the hazards of flying. I refer particularly to the air-speed meter and the ball-bank indicator. The greatest hazard in flying is the stall, particularly when one wing is stalled before the other as a result of yaw. As a stall warning indicator the air-speed meter is worse than useless, since the stall may occur at any air speed. The ball-bank indicator is not a direct indicator of angle of yaw. Yaw may exist with a ball-bank indicator centered, and the relationship between the angle of yaw and the reading of the ball-bank indicator varies from one airplane to another, depending upon the airplane resistance to sidewise motion, and varies in each airplane with the air speed. Furthermore, the form of this instrument, resembling as it does a spirit level, definitely has encouraged the student to correct for yaw with the ailerons, which is just what he should not do. It would be a simple matter to provide the airplane with instruments that would read directly in angle of attack and angle of yaw. The angle-of-attack meter would provide the student

TABLE 8

Comparative Operating Costs

Hours per year	100	200	1,000
Miles per year (80 m.p.h.)	8,000	16,000	80,000
Present Rates:			
Annual Cost	$1,015	$1,192	$2,608
Cost per hour	10.15	5.96	2.61
Cost per mile	0.127	0.074	0.033
Adjusted Rates:			
Annual Cost	$ 899	$1,066	$2,482
Cost per hour	8.89	5.33	2.48
Cost per mile	0.111	0.067	0.031
Automobile Rates:			
Annual cost	$ 608	$ 785	$2,201
Cost per hour	6.08	3.92	2.20
Cost per mile	0.076	0.049	0.027
Automobile Rates and Doubled Initial Cost:			
Annual cost	$ 841	$1,018	$2,434
Cost per hour	8.41	5.09	2.43
Cost per mile	0.105	0.064	0.030

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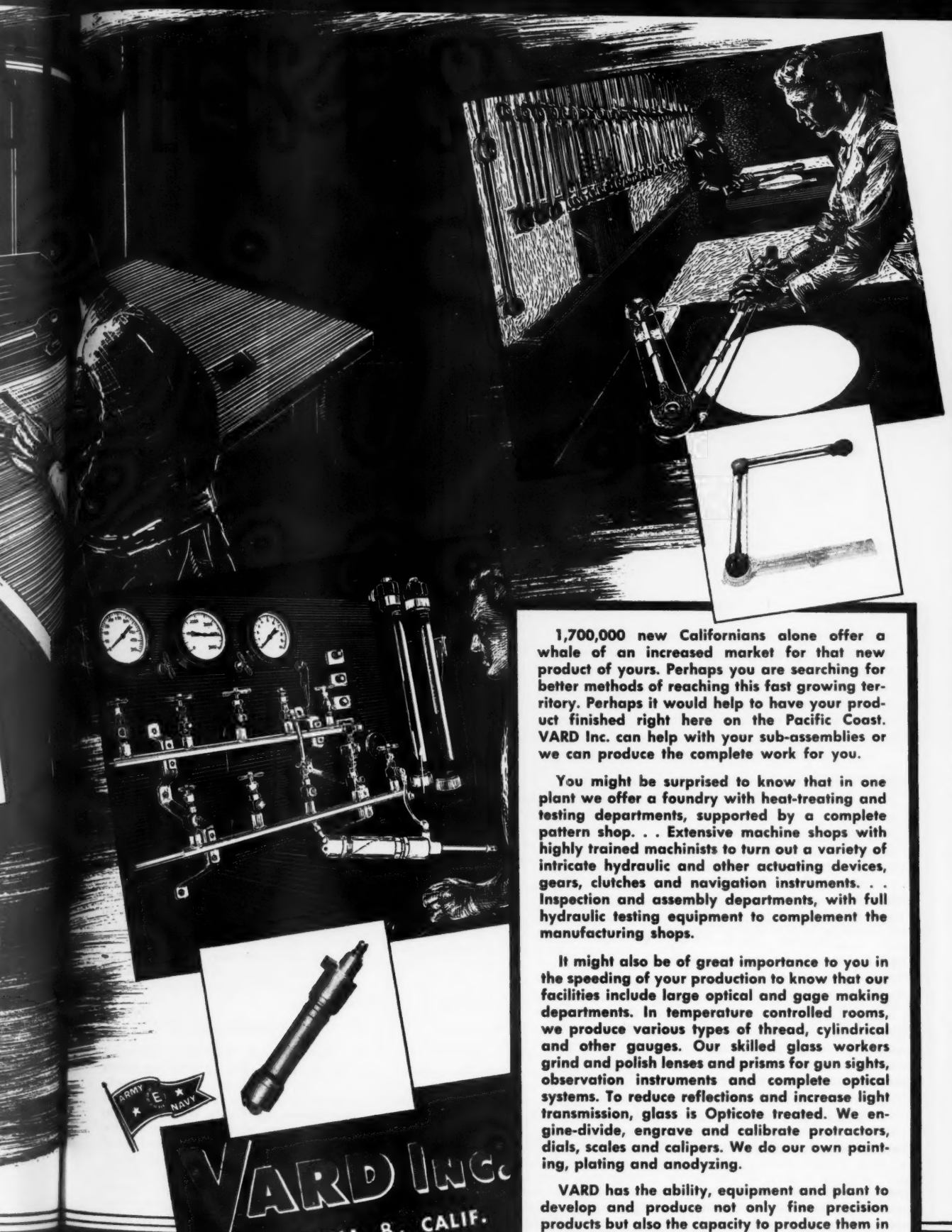

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with a stall warning that would be approximately correct irrespective of airplane loading, atmospheric density and, hence, altitude and temperature, degree of acceleration of the airplane whether in a pull out or a steep turn, and the amount of power being used. It would also indicate to him where he could get his maximum gliding range and where he could get his best climbing position independent of all of the above variables.

One of the most difficult things to learn in an airplane is to be able to determine its direction of motion. This being so and with no instrument to indicate to the student the direction of motion, it has been extremely difficult to teach the student that the direction of motion does not vary directly with the stick position or with the position of the nose relative to the horizon. I believe it would be safe to say that the majority of our stalling accidents, which have accounted for about 50 per cent of all fatal accidents, have been due to the attempt of the pilot to incline the flight path upward by pointing the nose higher than that position which would give the maximum upward inclination of the flight path. It would be simple to combine an angle-of-attack indicator and a yaw indicator in the form of an arrow in the pilot's cockpit which would always point in the direction in which the airplane was moving.

Control of Flying Speed

A characteristic of most of our prewar airplanes was that they speeded up when the throttle was closed and slowed down when the throttle was opened. Not only does this characteristic make flying more difficult, since it requires a retriming of the airplane for each change of throttle position, but it makes it almost impossible to teach that the elevators should be used as a control of speed and the throttle should be used as the control of the angle of the flight path in the vertical plane. I have had the pleasure of flying one airplane in which there was practically no variation of speed with throttle position, and it greatly simplified the control of the airplane, particularly in maneuvering around a strange field preparatory to landing. I realize that to build such a characteristic into the airplane might demand major changes in airplane design which might be considered undesirable, but I see no insurmountable problem in providing a trim mechanism that would be controlled by the throttle to accomplish the same purpose.

Propeller Control

Next to eliminating any change in speed with throttle setting, it would be highly desirable if some way could be found whereby one control could be provided which would control the inclination of the flight path throughout its full range including the steepening of the glide after the throttle is closed. There is one way of doing this which I do not believe has been given proper consideration. This involves the use of the reversible propeller. Trials of reversible pitch propellers ended in crack-ups in at least two cases. In both cases the pilots decided to go around again and opened the throttle with the propeller set in full reverse position. Undoubtedly these accidents were in some measure responsible for failure to continue with this development. This danger could be completely avoided by giving the pilot direct control of the pitch of the propeller and by using a speed governor to operate the throttle. Such an arrangement would have the additional advantages of reducing the possibility of the engine stopping and of making the inertia of the engine and propeller available for temporary increases in power available.

Inaccessibility of Airports

Next in importance to cost, as shown in the surveys, is the inaccessibility of airports, which is related to both cost and utility. It was noted previously that the cost of operation of the private airplane drops rapidly with increased annual usage and that the inaccessibility of airports must necessarily have a pronounced adverse effect upon the number of hours the airplane is flown per year. The effect of airport accessibility on the utility of the airplane is too familiar a subject to warrant my comments here. However, I have heard many people in the industry talk about the need for more airports and more conveniently located airports for the private pilot but always with the assumption that the responsibility for providing these airports rests wholly with the communities. The availability and the accessibility of the airports for the private flier is a function of how big these airports must be and what kind of surface they must have. These are things over which the communities have no control but they are wholly within the control of the industry. Private aircraft could be built so that small one-way landing fields could be used. If this were done, I am quite confident that these fields would be provided wherever there was the slightest demand for them. And I have reason to believe that when small one-way fields are placed adjacent to our main highways the major oil companies will put in service stations serving both the one-way field and the highway, giving to the private owner the kind of service he has been accustomed to receive in his automobile and which has been so sadly lacking in the service heretofore rendered to him in his airplane.

However, I would like to point out that it would be unlikely that such one-way fields would be provided if they could be used by only one make of airplane. If a considerable percentage of the private airplanes require large fields, large and, hence, inaccessible fields we will have. However, if a considerable percentage of the manufacturers of private airplanes do build their airplanes for short one-way fields, we will soon have them in number and the other private airplane manufacturers will be forced to follow suit.

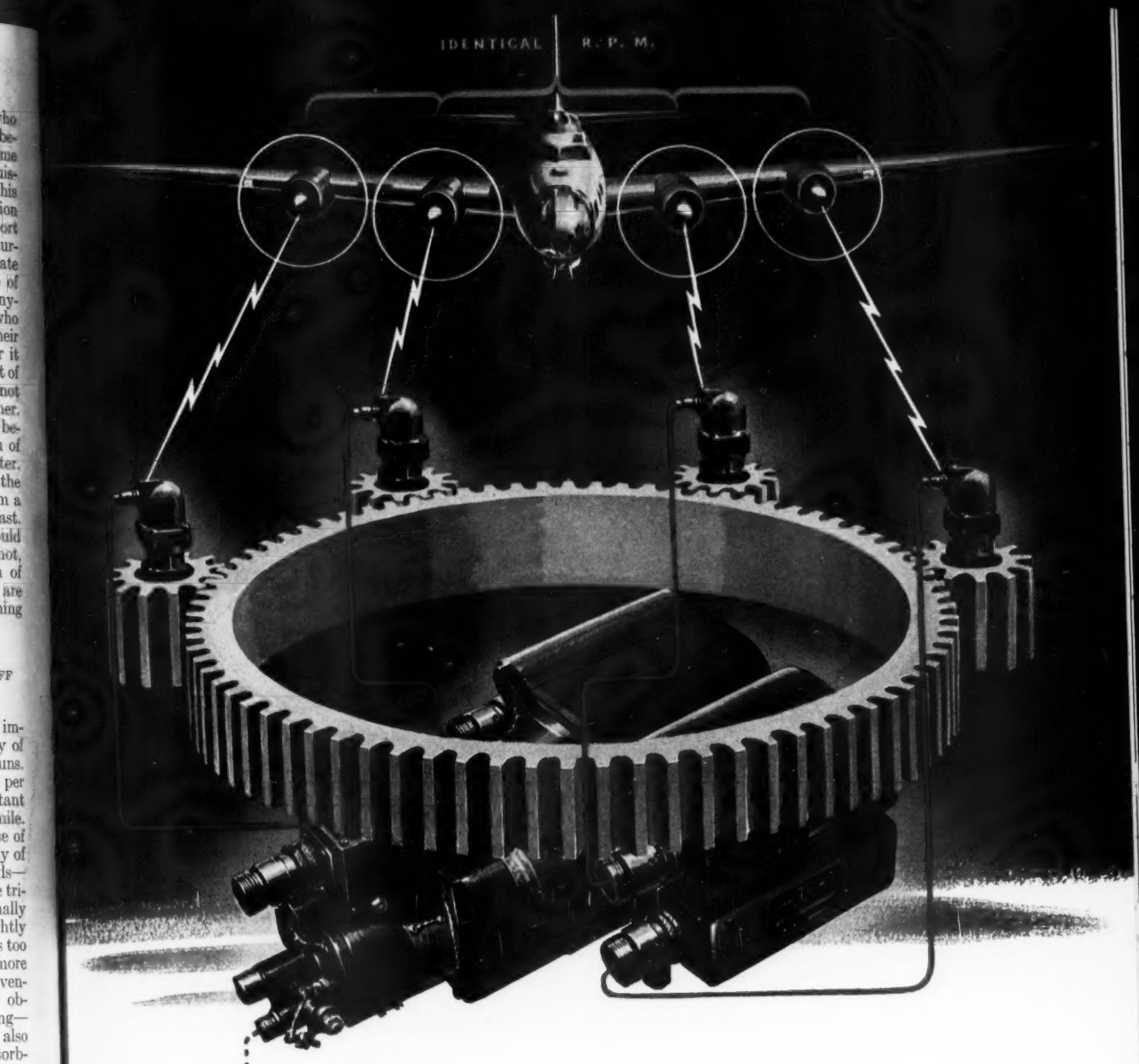
I am sure that there will be many who will not agree with this suggestion because it would necessarily have some adverse effect upon top speed or cruising range. However, in support of this suggestion I wish again to call attention to the extreme importance of airport accessibility as shown by the two surveys, to the large percentage of private pilots who fly only for the pleasure of flying and are not in a hurry to get anywhere, and to the fact that for those who are in a hurry it is time from their original point of departure (whether it be home or office) and their final point of destination that is important and not the time from one airport to another. If additional support is needed, I believe it can be found in the reaction of the public generally to the helicopter. About all that it knows about the helicopter is that it can operate from a small space and that it cannot go fast. I have talked to many people who could afford to buy airplanes, but have not, who have expressed their intention of buying helicopters as soon as they are available. This should mean something to you.

Reducing Landing and Take-off Runs

The use of a low wing loading immediately presents itself as one way of reducing the landing and take-off runs. It also reduces the cost of operation per hour, which seems to be more important than the cost of operation per mile. One of the past objections to the use of low wing loadings—i.e., the difficulty of landings and take-offs in high winds—has been eliminated by the use of the tricycle landing gear. I have personally had the pleasure of operating a lightly loaded airplane so equipped in winds too high to permit operation of much more heavily loaded airplanes with conventional undercarriages. The other objection to the use of low wing loading—i.e., susceptibility to bumps—could also be answered by the use of shock-absorbing wings. Again I can say that I have had the pleasure of flying an airplane so equipped and, although I was unable to check its performance against that of a fixed-wing airplane under the same air conditions, it was only necessary to observe the operation of the wing to know that it was performing its function.

Roadable Airplanes

Reference to the shock-absorbing wing brings me directly to the suggestion of roadable airplanes, since the shock-absorbing airplane was designed and constructed by Waldo Waterman, who has also done pioneering work in this field. I have read criticisms and heard numerous oral arguments to the effect that a roadable airplane can be neither a good airplane nor a good automobile and that it has no place in the aviation picture. I cannot agree. The personal airplane has not been salable in the past because it lacked utility and not because it was not a good airplane. It is evident then, particularly in view of the



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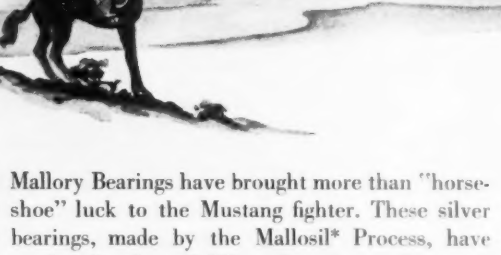

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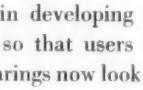

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result of the surveys, that airplane performance might well be sacrificed to improve its utility. I cannot believe that the extent that we would have to sacrifice airplane performance to secure roadability would offset the advantages of this roadability. I do not know to what extent Mr. Waterman sacrificed the performance of his airplane to secure roadability, but I did have the pleasure of seeing this airplane fly and it had the added weight of an automobile engine. In the case of the roadable autogyro with which I have had personal experience, the cost of providing the roadable feature was as I recall about 15 lbs. increase in empty weight. In England many of the personal airplanes have folding wings not for roadability but to reduce hangar rents. To make them roadable would not entail any great increase in weight.

Roadable airplanes do offer a partial answer to the problem of weather interruption for the private pilot which is not answered by the provision of more and more suitably located airports. It does not appear now that this problem will be solved in the immediate postwar period by the advent of radar. The mere presence of the roadable feature would permit private pilots to assay flights which they could not make otherwise for fear that they might be forced down and unable to complete their trip. In the event that such trips are attempted and the weather does become such that the trip cannot be continued by air it can be continued by highway, and the difference in time is measured by the difference in air speed and road speed and not by the duration of the bad weather. In many cases the weather limitations are of local nature and flight can be resumed after passing through the affected region. This was well demonstrated some years back by Jim Ray in an autogyro. In this case the clouds were down on top of the mountains. Jim flew as far as he could and then taxied over the range and resumed flight on the other side, although he did not have a roadable autogyro. He managed to get home while the rest of us remained grounded at Cleveland for two days because we could not get over the range.

"Fly It Yourself" Systems

The problem of weather interruption is also solved in the proposed "Fly It Yourself" systems, and any discussion of ways of increasing the utility of the private airplane would be incomplete without mention of this system. In this system it is proposed that airplanes rented at any one station in the system may be turned in at any other station in the system. In some cases it is also proposed that automobiles, as well as airplanes, could be so rented. With such a system the renter may change from the airplane to some other means of transportation at any time because of weather or other reasons, without incurring any obligation to return the airplane to its starting point. It is my personal opinion that in the postwar period such systems could be made to pay and that they would be a national asset because they would bring personal airplane transportation within the reach of many who could not otherwise afford it. It can be expected that in the immediate postwar period and probably for many years thereafter we will have hundreds of thousands of pilots who cannot afford a personal airplane who would make use of such a system if it were available. As was shown in Table 8, if the annual usage of the airplanes in such a system could be brought up to 1,000 hours per year, the cost per mile could be brought under 3 cents per airplane mile or under $1^1/_2$ cents per passenger mile.

Visibility

Unless increases in the utility of the personal airplane in the postwar period can materially alter the general character of private flying, increasing the pleasure to be derived from private flying is possibly more important than increasing utility. As was pointed out previously, about 50 per cent of the prewar owners and the prewar students were primarily interested in the pleasure to be derived from flying around their local airport. If we analyze the pleasure to be derived from flying, I believe we will find that it is practically all derived from our sense of vision. Certainly there would be little or no pleasure to be derived from flying under the hood. One of the pleasures of flying is that of pointing out things of interest on the ground to your passenger. But in most of our prewar airplanes what the pilot could see and what the passenger could see were two quite different pictures. I am sure many have found on occasions that the passenger had lost all interest in what was to be seen after the pilot had gone through the necessary maneuvers to place it within his range of vision. I have had the pleasure of flying two airplanes that had exceptional visual range from the cockpit, and as a result of this experience I am personally convinced that we should make almost any sacrifice in other characteristics of the airplane to secure this vision. Not only does it have a tremendous effect upon the pleasure of flying but it makes flying easier and safer. The latter is particularly important because, unless we do something about improving the vision for the pilot as the traffic density increases, we will have even more collisions and even more regulations aimed at preventing collisions. The percentage of fatal accidents due to collisions had already reached the sizable figure of 17.7 in 1939.

Both of these airplanes to which I have referred were pushers and this brings to my mind the article by Hugh de Haven, published in the March 1 issue of *Aero Digest*, which definitely condemns the pusher-type aircraft and suggests that such types now under consideration be abandoned. I sincerely hope that none will be influenced to abandon pusher designs because of this article, although I agree heartily with Mr. de Haven that careful consideration should be given in the design to the protection of the occupants in the event of an accident. His conclusions were necessarily based on accident records that included only one pusher-type airplane in any significant number. Furthermore, so far as I know, this did not include a study of the ratio of fatalities to the number of hours flown in this airplane as compared to others, and after all this is the important criterion of safety. If the total number of accidents can be reduced through improvement of vision by taking the engine out of the nose, this might well compensate for any increase in the seriousness of the consequences of particular types of accidents. I can state from my own experience that it is much easier to judge clearance over obstacles surrounding a field with a pusher than it is with a conventional tractor.

Noise and Vibration

Next in importance to improving vision in increasing the pleasure of flying is a reduction in noise and vibration. In my Detroit paper of 1935 previously referred to I stated that "soundproofing of cabins is not the answer to the problem of noise. If all of the people were in the cabins all of the time, this would be an adequate solution, but unfortunately most of the people are outside of the cabin most of the time, and it is when they are outside that we have to induce them to get inside." Apparently my remarks at that time were not taken seriously, since to the best of my knowledge the only effort to reduce the noise level was the installation of mufflers on one private airplane. Elimination of noise and vibration is, of course, not so simple as it may sound and may well demand sacrifices in some of the other characteristics of the airplane. I presume the industry figured that the gain would not be worth the cost. However, it does not know this to be true and in view of the past record it would seem to me to be well worth finding out. Personally, I do not expect that there would be many people who would hesitate in accepting an invitation to ride in an airplane that floated off and on to the airports without any visible or audible signs of effort and who would not thoroughly enjoy the ride. In this connection I should like to suggest the possibility of using a multiplicity of propellers driven by one engine. It is my impression that the noise level could be materially reduced thereby without an increase in the total weight of propellers and with an increase in their efficiency. It is also possible by proper distribution of slipstream to materially increase the angle of climb and decrease the minimum flight speed, as was done in the Crouch-Bolas airplane.

Light-Aircraft Engines

Some comments on aircraft engines would seem to be in order. From the standpoints of cost, noise, and inherent unbalance, I personally do not believe that there is now available an engine

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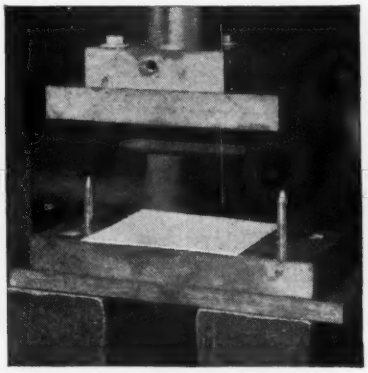
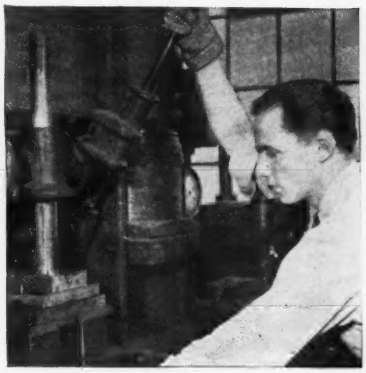


INSERT . . . Heated sheet is then placed in inexpensive wood mold in arbor press or where pressure can be applied to molds.



AND FORM . . . Pressure at approximately 100 pounds per square inch is applied, and shape left to cool briefly in mold. Resulting shape is permanent.

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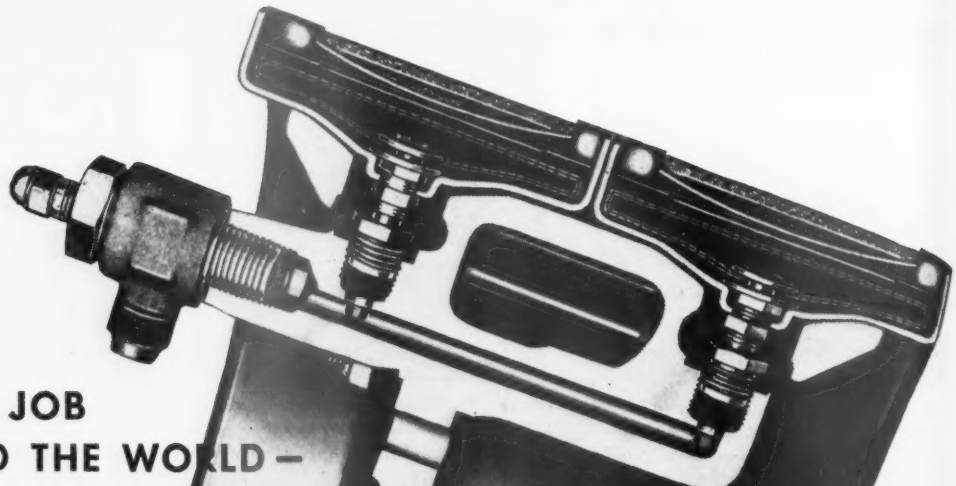

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suitable for the postwar private flying market. To secure as low a cost per horsepower as the manufacturers of small airplanes believe essential, it is necessary that engine design be so simplified that engines either can be produced cheaply in relatively small quantities or they must be produced in quantities exceeding any probable demand for personal airplane use. Almost all of them are inherently unbalanced and no effort has been made to quiet them. Perhaps I should qualify this statement, because there is one two-cycle engine about which I know little but which might become available for private airplane use. Much research work might be done in the development of a more suitable power plant for private flying, and it should certainly include work on two-cycle engines because of their simplicity. It would also be a boone to private flying if such research were to develop an engine whose power could be greatly increased at the expense of higher fuel consumption. Unfortunately, the reverse is true with the present types of engines, their specific fuel consumption increasing with decrease of power output.

I cannot agree with the many who contend that the development of the personal airplane and its power plant will follow the pattern of gradual refinement of the present designs. Nor can I agree that all worth-while developments come from well-equipped and properly staffed research laboratories. The entire history of the progress of society refutes these contentions. The airplane itself did not reach its first successful flight from a research laboratory, nor were the Wright brothers at that time considered to be scientists. The Hammond airplane, which had a combination of characteristics suitable for private flying which have not since been duplicated in any other airplane, was not a mere refinement of design, nor did it come from a research laboratory. I expect that in the future as in the past much of the real development of the personal airplane will be brought about by individuals with unorthodox ideas who have the stamina to stick to their ideas until they have proved that they were right.

Conclusions

It is up to the industry and to private capital generally to see that new ideas are given a fair trial. It is insufficient that the industry take on only those which it knows beforehand will succeed. It must also take on those which it does not know will succeed but which it does not know will fail and which, if they did succeed, would mark a forward step. An expansion of private flying is important to us as a nation, and private enterprise should do all within its power to provide as rapid a growth as is reasonably possible. The welfare of the country would demand that the Government promote this growth if private enterprise does not.

I personally hope that private enterprise does measure up to the test. However, I cannot help but wonder whether it will when I read the histories of the noteworthy developments of the past. In almost every case they are histories of hardships and privations for their proponents. This being the case, it follows inevitably that many worthwhile ideas must have been abandoned because those having them were unwilling to make the sacrifices demanded of them for their development. As an example, one might take jet propulsion which has had so much publicity recently. How many such projects have been turned down in this country would be difficult to determine, but undoubtedly there were many. I recently asked why we had taken on the English development rather than one of our own. The reason given was that Captain Whittle had secured experience in England which none had acquired here. The reason for this was that no one here had been able to get financial support for his ideas. I have a deep respect for Captain Whittle and his work, but I am sure he would be one of the first to say that there were probably many in this country who could have done as well as he did in England if they had had the opportunity.

A slightly different kind of example can be found in the helicopter. Before the flight of the Sikorsky helicopter it would have been extremely difficult to secure finance for such work. After its flight, capital has sought out inventors and engineers to finance their work. There are now about 50 such projects under way, and yet there were no new ideas in the Sikorsky which will make their success possible now where it would have been impossible before. Some time ago I asked Mr. Sikorsky how long he had been in possession of the knowledge necessary to design his machine. He stated that he could have designed it any time after the Cierva Autogyro was invented and that was over 20 years ago.

These thoughts are, I believe, worthy of serious consideration. The market for prewar personal airplanes was a limited one. The ultimate market is a vast one. The country's interest demands that this gap be rapidly closed. It is up to the industry to close it.

(*Continued from page 43*)

olic glues increased the strength, weathering properties, and mold resistance of the skin, the development of the cycle-weld procedure made possible the use of metal for the load-carrying outer layers. This last item should be particularly emphasized, since it opens up a field of entirely new possibilities for the efficient design of fittings which formerly was the weak point in wood construction.

A few additional merits of the sandwich skin are the damping of vibrations and the good insulation against noise and heat. Its attractiveness for the light cabin plane is enhanced by great local strength and rigidity. The pilot and the passenger need not be afraid of leaning against a sandwich wall or stepping on any part of a sandwich floor. It can carry such loads safely. Indeed, a sandwich type fuselage is itself a natural double-walled cabin which combines functional structural design with luxury. It will be possible to construct a small cabin plane on the sandwich principle which is just as streamlined and racy as the fighter or bomber plane flown at present by the potential postwar purchaser of the light plane at a cost he can afford.

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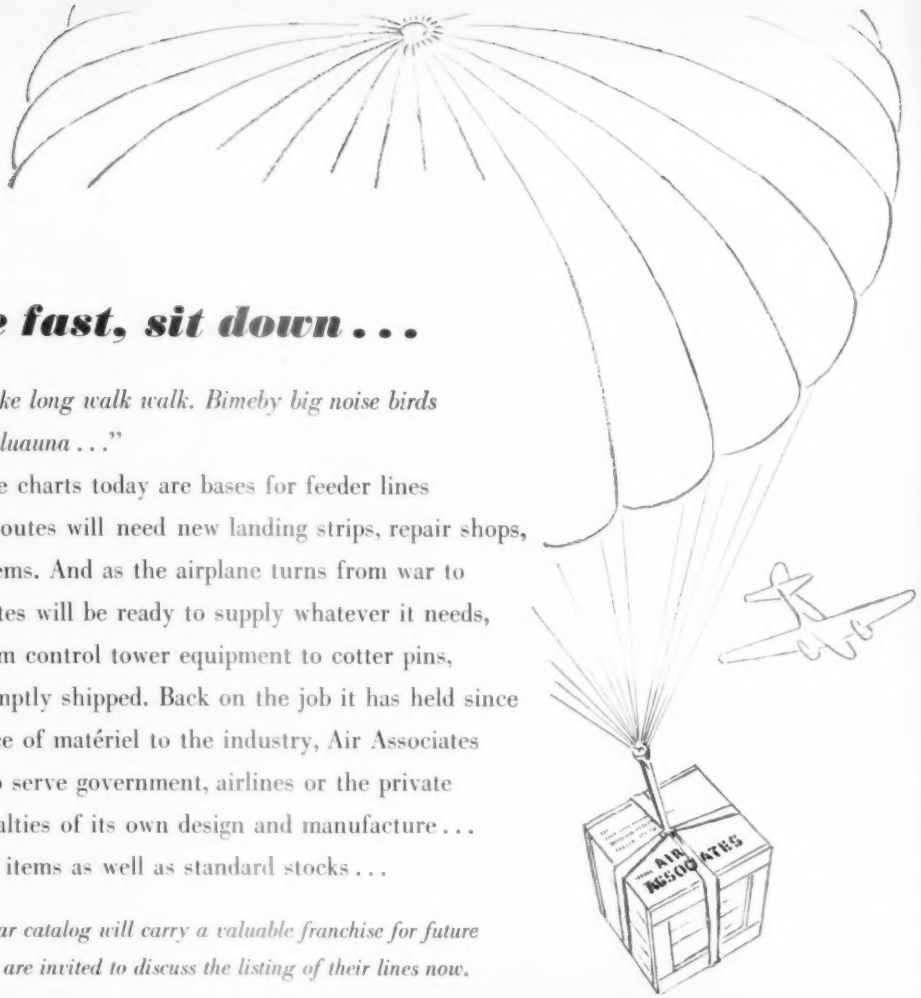

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Introduction

The commercial use of a high-strength, natural aging aluminum alloy is relatively new in industries that have been accustomed to depend upon heat-treatment for high-strength alloys. The use of a natural aging alloy should be of outstanding interest to the aircraft industry, since intricate parts must be made free from warpage, distortion, or cracks. To obtain such castings is often difficult where high temperature solution and quench treatments are necessary. With a natural aging alloy, high strength is obtained without any high-temperature solution or quench treatment.

The advantages of such an alloy over heat-treated alloys are evident, since the following objectives are accomplished:

(1) Severe stresses, caused by quenching, which are likely to cause cracking, are avoided.

(2) Warpage due to high temperature, especially on long thin sections or rapid changes of section, and subsequent straightening operations are avoided.

(3) Expensive heat-treating equipment to handle large castings is unnecessary.

(4) Production delays due to fitting heat-treatment to foundry production are not encountered.

Present Alloys

At the present time the aircraft industry is consuming many castings of an aluminum-zinc-magnesium-titanium-chromium natural aging alloy, usually designated as 5.25 zinc alloy,[1] commercially known as Frontier 40E. Castings of this alloy are in regular production in parts that must withstand 300 lbs. hydrostatic pressure. Other parts are incorporated in oxygen control units for high-altitude flying, self-sealing gasoline tanks, undercarriage parts, radio equipment, radar, airplane oil-line inlets, and the top turret of the Flying Fortress. The approximate chemical composition of the alloy is shown in Table 1.

The high-strength characteristics of the alloy are so well established that it has been given numerous specifications, the more important of which are: Army-Navy Air Corps, An-A-17; Navy, Bureau of Ships, 46 A1, Class 1; and A.S.T.M., B26-41T, Alloy ZG-41.

It is also referenced under Class A castings in the *Handbook of Instructions for Airplane Designers* (restricted).

The minimum physical properties for the alloy are given in Table 2.

When it is stated that the alloy attains high strength through natural aging, it is meant that the physical properties are equivalent to or better than those obtained from the high-strength heat-treated alloys. To illustrate this fact the Air Corps Specification for the 5.25 zinc alloy is shown along with those of three prominent sand-cast and heat-treated alloys in Table 3.

The properties of the 5.25 zinc alloy are for as-cast condition, while those of the others listed above are for sand-cast material solution heat-treated and quenched, followed by aging.

Another outstanding characteristic of the 5.25 zinc alloy is its ability to re-age when cooled to room temperature after exposure to high temperatures. Test pieces were held for 2 hours at temperatures as high as 1,050°F. and allowed to air-cool. Upon standing at room temperature, the test pieces soon attained physical properties equivalent to those of the same material which had not been exposed to the high temperatures. Results of some of the tests are given in Table 4.

These results indicate that there should be a wide field of use for this alloy for parts that are to be brazed. Recent publications give the advantages and reasons for brazing as opposed to welding and an outline of the various methods used.

Table 1

Zn	Mg	Cr	Fe	Ti	Cu	Si	Mn	Al
5.25	0.50	0.50	1.0*	0.2	0.4*	0.3*	0.3*	Rem.

* Maximum.

Table 2

Yield strength, lbs. per sq.in.	22,000
Tensile strength, lbs. per sq.in.	32,000
Per cent elongation in 2 in.	3.0
Brinell hardness (500 kg., 10-mm. ball)	70–80
Modulus of elasticity	10,000,000
Endurance limit, lbs. per sq.in.	9,000
Specific gravity (70°F.)	2.81
Linear coefficient of thermal expansion, 70–200°F.	0.0000137
Weight per cu.in. (lbs.)	0.10
Proportional limit, lbs. per sq.in.	14,000–16,000
Charpy impact (ft.lbs.)	2–3
Shear strength, lbs. per sq.in.	27,000
Patternmakers shrinkage, in. per ft.	3/16

Table 3

Spec.	General Type of Alloy	P.S.I. (Min.) Yield	P.S.I. (Min.) Tensile	Elong. (Min.) % in 2 In.
AN-A-17	5.25 Zinc	20,000	32,000	3.0
AN-QQ-A376	5% Si, 0.5% Mg	20,000	32,000	2.0
AN-QQ-A364	7% Si, 0.3% Mg	20,000	30,000	3.0
AN-QQ-A390	4% Copper	18,000	32,000	3.0

Presented at the Materials Session, Twelfth Annual Meeting, I.A.S., New York, January 25–27, 1944.

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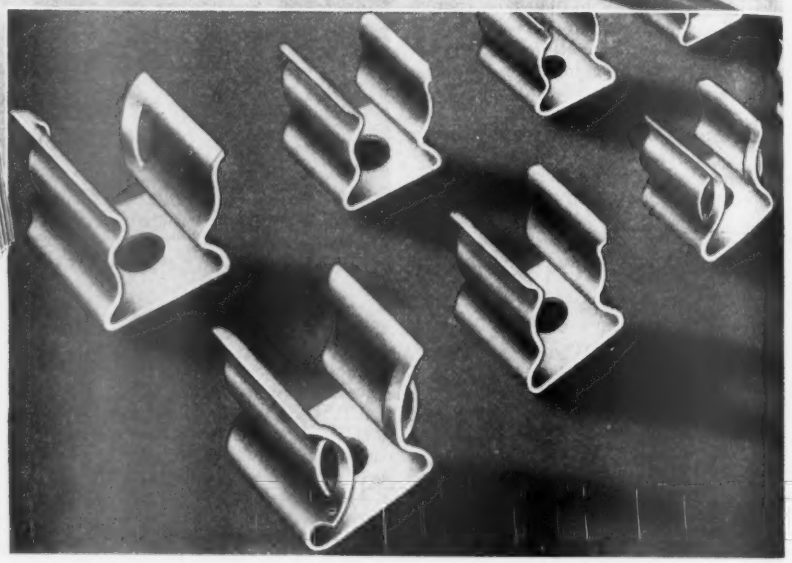

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TABLE 4

	P.S.I. Yield	P.S.I. Tensile	% Elong. in 2 In.
21 days R.T. No high temp.	25,000	36,700	6.5
2 hr. 900°F., air cool, aged 21 days R.T.	25,100	35,600	5.5
2 hr. 1,000°F., air cool, aged 21 days R.T.	25,400	36,800	6.0
2 hr. 1,050°F., air cool, aged 21 days R.T.	24,800	38,300	6.0
2 hr. 1,000°F., air cool, reheat 2 hr. 1,000°F., air cool, aged 21 days R.T.	25,550	36,000	5.25

BRAZING AND WELDING

"Brazing differs from welding in that special fluxes and filler material having a lower melting point than that of the parent material are used for making the joint without melting the parent parts. The cost of brazing is generally less than the cost of either gas or arc welding and brazed joints are neater and require less finishing. Furthermore, parts too thin to be welded may be satisfactorily brazed.

"Brazed joints are classed by the methods used in applying the brazing heat. These are: furnace brazing, torch brazing, and dip brazing. Furnace brazing is done by applying a flux, assembling the parts, and raising the entire assembly or batch of assemblies in a furnace to a point that will cause the filler material to melt and flow into the joint, but without melting the parent parts.

"Torch brazing is done by dipping the filler material in a flux and melting into the joint with a torch. Both torch and furnace brazing are in use on a production scale, and the materials and techniques for each have been standardized.

"Dip brazing is done by assembling the parts and dipping the entire assembly into a bath of molten flux held at a temperature somewhat above the melting point of the filler material, but below the melting point of the parent material. This method offers interesting production economies; however, it is not yet used on a production basis."[2]

It is further stated that: "Since brazing requires heating the alloys above their annealing temperature, designs involving the use of non-heat-treating alloys must be based on the strength of the annealed or soft temper of the material."[2]

With the 5.25 zinc alloy this would mean that because of the re-aging characteristic of the alloy the parent metal would quickly regain its original strength and the result would still be a high-strength metal. Since there is such a demand for an aluminum alloy that can be brazed without loss of properties to a parent metal, a great deal of work is being done to determine the brazing possibilities, brazing temperature, and proper flux for the 5.25 zinc alloy.

Light Metals says: "Heat-treatable aluminum alloys result in higher strengths than are possible in the non-heat-treatable alloys but the material must be quenched after removal from the brazing furnace and then aged. The same results can be obtained by following the brazing operation with a solution heat-treatment, quenching, and aging."

The 5.25 zinc alloy is an exception to the above statements since properties comparable to heat-treated alloys are reobtained without any quench or re-heat-treatment being required. The parts are simply allowed to air-cool, at which time re-aging starts and high properties are thereby reobtained. This should be particularly applicable in the aircraft industry where no warpage or cracking is desired in the assembly. Where the brazed assembly may be intricate or bulky and thus difficult to submit to the heat-treatment in its entirety, the natural re-aging tendency of the 5.25 zinc alloy eliminates those problems.

RESISTANCE TO CORROSIVE ATTACK

With regard to the resistance of brazed aluminum joints to corrosive attack, the following statement has been made.

> "There is not yet sufficient experience to establish definitely the resistance of brazed aluminum joints to corrosive attacks. However, there has been enough testing in salt spray, atmospheric, and other kinds of exposure to indicate that the corrosion resistance of brazed joints is comparable to that of welded joints in the same alloy. If the exposure conditions are such that the parent material would need protective paint coatings, the brazed joints in the assembly should be given the same treatment. If the aluminum parts need no protection, it is quite likely that the brazed joint also will perform satisfactorily without it."[2]

The corrosion resistance of the 5.25 zinc alloy is excellent. It is far better than the heat-treated 4 per cent copper alloy and is comparable with the heat-treated 7 per cent Si, 0.3 per cent Mg alloy.

Much attention has also been given recently to the problem of stress corrosion. Corrosion fatigue results from the joint action of corrosion and fluctuating stress where multiple cracks are generated under lower values of stress than in the absence of corrosion. It is considered that the destructive action of fluctuating stress in conjunction with even mildly corrosive conditions is due to the breakdown of a protective surface film formed on the metal by adsorption of oxygen from the atmosphere. Corrosion resistance depends on the resistance of the surface film in the particular medium and the rate at which the film can be repaired when it is broken down. Thus, corrosion resistance, not the normal mechanical properties of the metal, is the important determining factor in the life of any part under such conditions. In designing parts to work in contact with salt water or other corroding medium, the designer should appreciate the importance of corrosion resistance.[3]

Although aluminum alloys containing zinc have been known to metallurgical fields for many years, they were not in general use, principally because of prejudices that had been passed along through the years. One of the greatest of these was the belief that aluminum alloys containing zinc corroded rapidly.

ALLOYING TO REDUCE CORROSION

Investigation has evidenced that alloys of aluminum with as high as 9 per cent zinc with machined surfaces showed practically no deterioration after immersion in sea water for 448 days. This indicates that zinc alone does not impair the corrosion resistance. The same authorities found serious corrosion both in sea water and tap water when their alloys contained both zinc and copper. Most aluminum base alloys containing zinc, which have been used either in the United States or abroad, have contained copper for strengthening purposes, and the poor corrosion resistance of these alloys counts for the prejudice against aluminum alloys containing zinc, although the poor corrosion resistance was not due to zinc alone but to the combination of zinc and copper. The report also stated that alloys containing magnesium and zinc showed good resistance to corrosion.[4]

Magnesium, silicon, and zinc are the best additions to aluminum to retain corrosion resistance, and the addition of chromium and titanium further improves the natural corrosion resistance of the 5.25 zinc alloy.

Some authorities have even gone so far as to say that aluminum alloys in which zinc and magnesium do not exceed 6 per cent are practically stress corrosion-proof.[5]

SHOCK RESISTANCE

Another excellent property of this alloy is its exceptional ability to withstand shock. Standard shock tests such as the Izod and Charpy have not been found to be entirely satisfactory for this purpose because notch sensitivity has a great bearing on the test results and the tests are limited as to the rate of application of the shock load. In actual practice a part is subjected to shell impact, bomb explosions, and similar types of shock. To simulate these conditions it is necessary to employ an explosive medium for imparting shock to the part being tested.

Shock tests using an explosive were actually made on five standard alu-

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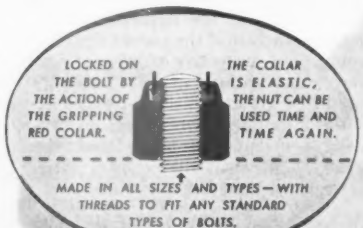
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minum alloys, including the 5.25 zinc alloy and the heat-treated 4 per cent copper alloy, 5 per cent magnesium alloy, 5 per cent silicon alloy, and the 7 per cent silicon, 0.3 per cent magnesium alloy. Measurements were made on the pieces before and after the explosive test. The 5.25 zinc alloy was superior to all of the other alloys in resistance to explosive shock. Not only did it resist breaking but the deformation was less, which means that parts made from the alloy would be less out of alignment and less likely to render the piece inoperable after explosive shock.[6]

Age Hardening

The high physical properties of the 5.25 zinc alloy are due to the phenomenon known as aging(or age hardening). The term "age hardening" means, literally, increase of hardness in the course of time—in actual practice it means general improvement of various mechanical properties, the time taken for this depending upon the nature of the alloy.

Aluminum alloys that age-harden are not new, this phenomenon has been known and investigated for years; however, it was usually found to occur after solution heat-treatment and quench. The 5.25 zinc alloy ages naturally at room temperature without any previous quench or solution treatment. After the metal is cast and allowed to stand at room temperature, a change in physical properties takes place rapidly at first and slowly later in the process. Yield and tensile are raised considerably and elongation is progressively decreased. The alloy reaches the required properties within 3 weeks at room temperature, and then the properties start to level off and change little thereafter. Where it is undesirable to wait for the natural aging cycle, the alloy can be artificially aged at low temperature for a short time. This accelerates the aging, relieves any casting strains, and stabilizes the metal so that close tolerance machining can be done without growth or warpage occurring.

The natural aging curve is shown in Fig. 1.

Causes of Age Hardening

The actions and theories of age hardening are generally well known, and discussions of the reasons for it have raged back and forth for a long time. For that reason no effort will be made to delve too deeply into the subject or to take sides in the arguments. The remarks in this paper concerning aging will be restricted to a simple summary of what is believed to occur during aging.

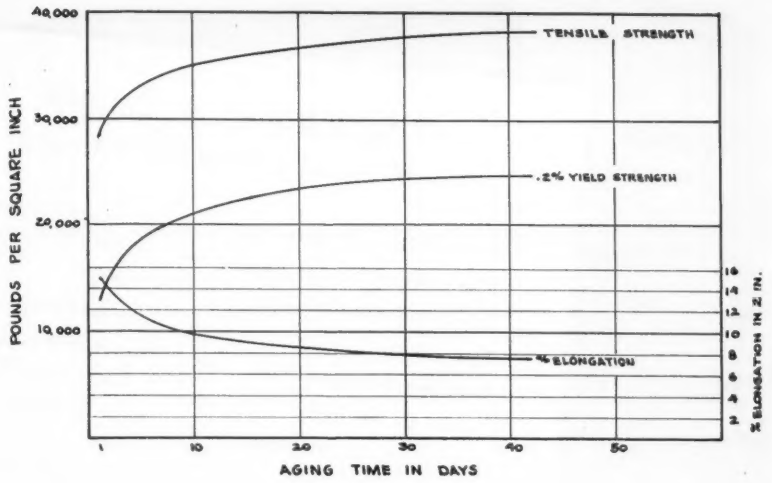

Fig. 1.

Aging can occur in an alloy when some constituent is more soluble at a higher than at a lower temperature. Being supersaturated and metastable at lower temperature, there is a natural tendency, slowly at ordinary temperatures and more rapidly if the temperature is slightly raised, to precipitate out of solid solution some of the dissolved constituents. Precipitation of the excess constituent occurs in the form of submicroscopic particles distributed throughout the mass of the solid solution, and this causes the hardening.[7]

There are many reasons advanced to explain this phenomenon. One of the more common is the theory that the submicroscopic particles cause hardening because they are believed to act as keys on the crystallographic planes of easy slip of the matrix by interfering in some manner with the relative movement of crystal fragments along these planes.

Some argue that aging is due to the effect of atomic forces acting between the minute particles and their surroundings, or the particles being of colloidal size rumpling the slip planes or upsetting the space lattice, or lattice distortion without necessary precipitation of particles at all.

The form and extent of distribution of the precipitate has a pronounced effect on the mechanical properties. Best tensile properties usually result from the most highly dispersed condition of the precipitated phase with the finest possible state of division. In the 5.25 zinc alloy this occurs with natural aging. The compound is most likely to be rejected at the grain boundaries and along certain crystal planes within the grain. Excessive grain boundary precipitation at the expense of intergranular action is undesirable. Similarly, relatively slow rates of aging are to be preferred since the fine division and minimized coalescence gives the optimum properties.

Alloys containing $CuAl_2$, Mg_2Si, and Mg_2Al_2 are all capable of being hardened by suitable heat-treatment, but none of these are known to have the rapid natural aging tendency of the aluminum-zinc-magnesium-chromium titanium alloy.

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[1] Comstock Patent 2,146,330 assigned to Titanium Alloy Manufacturing Company, Niagara Falls, N.Y. This company has assigned to the Frontier Bronze Corporation exclusive rights for all uses under this patent with the right to sublicense other foundries.

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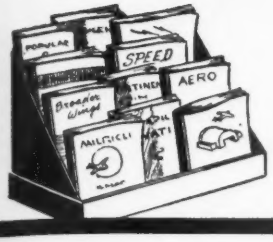

Periodicals

The views and opinions expressed in this section are exclusively those of the writers or publications named. They are in no case to be construed as those of the Aeronautical Engineering Review or the Institute of the Aeronautical Sciences.

Accessories and Equipment

Problems of Airman Rescue. Albert A. Arnhym. This article summarizes the equipment that has been devised for the rescue of airmen who have been forced to abandon their aircraft. Beginning with a comparison of the conditions characterizing the rescue of airmen in the first World War with those existing at present, the article goes on to define the economic and military considerations that supplement the humanitarian motive in making the rescue of present-day fliers so important. It then surveys the devices that help the man who must abandon his plane to get out of the plane, to reach the ground, and to get home. In discussing the equipment developed for meeting the contingencies of reaching ground, seven problems are covered: (1) how to avoid collision with the falling plane or debris; (2) when to open the parachute; (3) provision of sufficient air for breathing; (4) protection against cold; (5) protection against enemy fire; (6) how to direct the parachute toward a desirable landing place; and (7) how to make a safe landing. In the matter of equipment for survival, once the airman has reached the ground several sets of conditions are considered. These consist of landing in populated and unpopulated areas and alighting on water near shore and in mid-ocean.

From the summary, three conclusions are reached: (1) The development of rescue equipment has progressed to such a degree that, in spite of the greater scope of modern aerial warfare, the return of airmen from a disabled plane to their base has been made more probable and less dangerous. (2) It must be assumed that the same reason that prompted the development of this equipment—namely, the military value of experienced airmen—will induce the enemy to devise means to decrease its effectiveness and thus prevent or complicate the rescue of parachuting airmen. (3) With the expected postwar increase in ocean flying, the rescue equipment created and proved effective during the war will greatly aid in making nonmilitary flying far less hazardous. *Aero Digest*, June 15, 1944, pages 109–111, 126–128, 130, 7 illus.

Aircraft Heating Systems of Three Types. Wilbur W. Reaser. Six properties of an airplane that must be ascertained before the various parts of the heating system can be designed are listed. After discussing various factors involved in the design of efficient heating systems, the writer describes the steam system, exhaust hot-air heater system, and the internal-combustion heater. Both general design considerations and the details of design are discussed. Drawings of the three systems of heating aircraft augment the text. *Automotive and Aviation Industries*, June 15, 1944, pages 32–35, 94, 96, 98, 4 illus.

Electrical Bonding in Airplanes. W. H. Arata. Indicating the purposes served by electrical bonding in aircraft, the writer records the standards and specifications set up by the Lockheed Aircraft Corporation for the regulation of bonding at its various plants. In addition to illustrations of typical bonding applications, the article is supplemented by three tables: One shows the order in which electrical bonding jumpers are used for Naval aircraft, the second tabulates acceptable products, and the third offers typical cost comparisons. *Aero Digest*, June 15, 1944, pages 120, 138, 7 illus.

Aerodynamics

Directional Stability of Flying Boat Hulls During Taxiing. John D. Pierson. Increased loading of flying boats to the maximum operational limit has led to a renewed interest in the directional stability characteristics of hulls. Cases have arisen wherein yawing at speeds below the hump has prevented take-off. Also, cross-wind operation is often impossible below hump speed because of weathercocking. At these low speeds rudder effectiveness is slight and unbalanced power would reduce accelerating forces with the net result that inherent directional instability is uncontrollable.

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Investigation of these characteristics was made on several flying boat models in the Experimental Towing Tank, Stevens Institute of Technology. Yawing moments versus yaw angle were determined at various model speeds and loadings. Assembling of these individual stability curves on a grid of loading versus speed formed the composite charts of directional stability which show the overall picture of the hull directional stability. The charts exposed regions of severe instability on the basic hull forms.

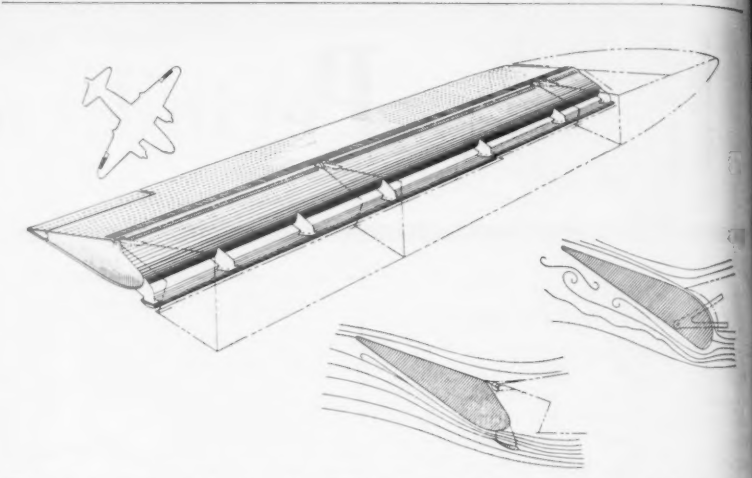
Tests of the forebody alone demonstrated its responsibility for the low-speed, moderate instability and showed that the flow along the rounded afterbody lines caused the severe discontinuities near hump speed. Modifications to straighten or separate this flow on the afterbody were tested in a similar manner and included skegs along the keel and under the tail cone and chine strips and side steps near the second step. The side steps were most effective on the models and were applied full scale.

Flight-test results, while qualitative in extent, indicated substantial improvement in the taxiing performance of the ship. *Journal of the Aeronautical Sciences*, July, 1944, pages 189–195, 14 illus.

Fuselage Influence on the Airflow at the Propellers of a Multiengined Airplane in Yawed Flight. R. P. Harrington and Victor Zadikov. The paper develops expressions for the aerodynamic interference of the fuselage of multiengined airplanes on the propellers for the general case of yawed flight. Such effects of the fuselage are considered as increased or decreased velocity components—one of which is parallel to the axis of rotation of the propeller; and the other, along a radius of the fuselage cross section in the plane of the propeller. The latter velocity component is later expressed as a tangential increment at any radius and position of the blade.

The fore part of the fuselage is approximated by an ellipsoid of revolution. The disturbances attributed to the fuselage are considered as those due to an additional potential that satisfies the equation of continuity and the boundary conditions at the surface of the ellipsoid—i.e., that the normal velocity components at the surface vanish. The development is facilitated by the application of ellipsoidal harmonics. The coordinate system consists of confocal ellipsoids of revolution and hyperboloids of two sheets. The third coordinate is the angle of rotation about the major axis of the ellipsoid. The velocity components desired are found by differentiating the additional potential partially with respect to the line element in the desired direction.

Values of the disturbing velocities expressed in terms of W_0, the resultant velocity of the airplane, are worked out for a special case of propeller location. The effect of these velocities on the angle of attack of a blade element at 75 per cent radius is depicted by curves for yawing angles between $\pm 90°$. When the propeller diameter is assumed to be $3b$, where b is the maximum radius of the fuselage, and is located in a plane at $1.2b$ from the nose with its axis located $2.75b$ from the centerline of the fuselage, the angle-of-attack increments of the element amount to 2.6° at certain blade positions for a typical installation at zero yaw. *Journal of the Aeronautical Sciences*, July, 1944, pages 205–212, 6 illus.



This new type aileron, developed by William D. van Zelm of The Glenn L. Martin Company, is designed to provide better lift characteristics.

The Thermodynamics of Air at High Velocities. Neil P. Bailey. The flow of air at velocities near and above sound velocity is involved in an ever-increasing number of cases, and a satisfactory solution often requires the use of the highly specialized tools of modern fluid mechanics. However, there are many engineering problems that may be solved with sufficient accuracy in terms of average velocities without following through the paths of individual particles.

When these thermodynamic equations of high velocity gas flow are solved in terms of such variables as velocity and density, they are not simple or easy to handle. If Mach Number is used as a primary variable, all of these equations become quite simple and usable.

This is illustrated by the solution of the cases of flow with friction and with heat transfer and for nozzles and diffusers with and without friction. Diffusers are discussed in more detail and measures of diffuser performance are suggested because, in proportion to their importance, they have received far less attention than nozzles.

In conclusion, the case of flow through plane shock waves is solved in terms of Mach Number and the theoretical correction for impact tubes in superacoustic flow is worked out. *Journal of the Aeronautical Sciences*, July, 1944, pages 227–238, 11 illus.

Effect of Dive Brakes on Airfoil and Airplane Characteristics. Philip G. Blenkush, Raymond F. Hermes, and Merle A. Landis. Tests have recently been completed at the University of Detroit 7- by 10-ft. wind tunnel to determine the effects of double split flap dive brakes on the lift, drag, and pitching moment characteristics of an airfoil and an airplane model. An NACA 0015 rectangular airfoil of 6-ft. span and 1-ft. chord was used for the airfoil tests. This was equipped with both perforated and nonperforated dive brakes that measured 25 per cent of the chord and 60 per cent of the span. These were mounted at the trailing edge at a deflection of 60° with respect to the chord line. A low-wing airplane model of 6.67-ft. span was also used for the tests. This model was equipped with perforated double split flaps measuring 25 per cent of the wing span and 15 per cent of the mean aerodynamic chord. Tests were made with variations in both chordwise and spanwise position of the dive brakes.

The information obtained from these tests shows that trailing-edge dive brakes tend to decrease lift curve slope at low angles of attack but increase it at higher angles of attack. Maximum lift, as well as the angle of attack at which it occurs, is increased in all cases. Moving the dive brakes forward on the chord results in a lift curve having a reduced maximum lift, as well as a reduced and varying slope.

Substantial drag increases are experienced with all dive-brake installations on both airfoil and airplane. In this case the advantage falls to the forward dive-brake location with about twice the drag being produced. Slight variation is shown between the perforated and nonperforated types.

In the case of airfoil pitching moments it was found that dive brakes at the trailing edge tend to shift the moments in the positive direction. For the airplane tests fore-and-aft location, as well as spanwise position, indicates considerable variations in pitching moments and stability. Likewise, tail position relative to the wake produced was found to have definite significance. *Journal of the Aeronautical Sciences*, July, 1944, pages 254–260, 10 illus.

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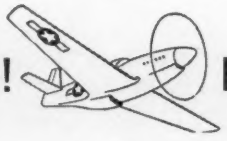
KEEP 'EM FLYING!  BUY BONDS!

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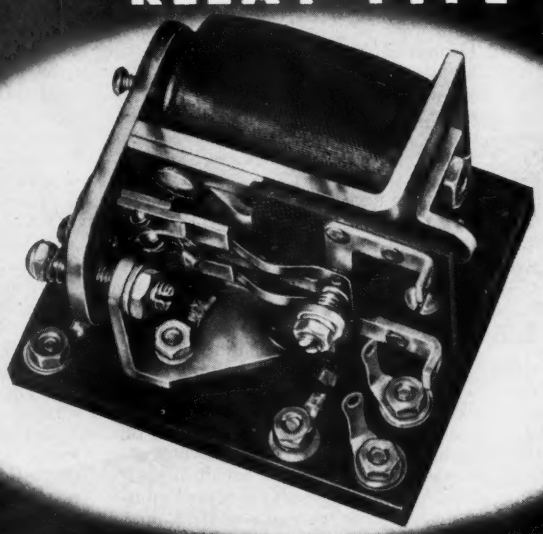

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Nozzles for Supersonic Flow Without Shock Fronts. Ascher H. Shapiro. Flow patterns for compressible fluids at supersonic velocities are discussed, and it is shown that shock fronts form when neighboring Mach lines (envelopes of wave fronts originating from point disturbances) intersect.

A criterion for divergence of Mach lines s developed for cases in which the passage is symmetrical in two or three dimensions and has a straight axis. This criterion is used as the basis for designing supersonic nozzles and diffusers. The analysis indicates that only a nozzle of infinite length can discharge a parallel stream into a tube of constant cross section without the formation of shock fronts. Methods are presented for designing nozzles of finite length, with the ntensity of shock fronts reduced to as small a value as possible, and it is shown that nozzles of reasonable length may be designed so that shock fronts are insignificant.

Experimental observations indicate that the proposed method of nozzle design is a practical one. With regard to supersonic diffusers having a straight axis, it is shown that shock fronts cannot be avoided even though the diffuser is of infinite length. However, the methods described in this paper may be used as an aid in determining the best diffuser design. *Journal of Applied Mechanics*, June, 1944, pages A-93–A-100, 9 illus.

Velocity in a Two-Dimensional Laplacian Potential Flow. Max M. Munk. A second article dealing with two-dimensional Laplacian potential flow contains a study of the absolute magnitude of the velocity and of the velocity distribution in such a flow as contrasted with the distribution of the velocity components. It is stated that the logarithm of the velocity must be a solution of Laplace's equation and that the products, or any powers or products of powers, of any such velocity distributions must be possible velocity distributions of the type considered. This knowledge is used to find expressions for velocity distributions that should be useful in analytical work. *Aero Digest*, June 15, 1944, pages 88, 90, 3 illus.

Forced and Free Motion of a Mass on an Air Spring. B. Sussholz. Results are given of a theoretical investigation of the transient response of a simple nonlinear mechanical system to various types of applied forces. A cylindrical tube closed at one end, with a light piston inserted in the other, was used experimentally, the nonlinear elasticity of the confined column of air governing the motion of the piston. Such systems have been used in ballistic studies to measure transient pressures, as well as for the measurement of pressures caused by other types of explosions in air. *Journal of Applied Mechanics*, June, 1944, pages A-101–A-107, 19 illus.

Wing Lift Distribution. W. L. Morse. The writer applies Schrenk's approximate method for obtaining spanwise lift distribution to two cases, one a wing without twist, and the other the same wing with twist. The nomenclature of Schrenk's article is altered to conform to British usage, and a certain amount of explanatory matter is added in order to make the method more easily understood. The case of a curved twisted wing is not specifically dealt with in the article but the method outlined in one of the examples is the same as would be used for such a case. It is stated that the approximation developed is more rapid than the usual Fourier series method, and that the loss of accuracy is extremely small. *Aircraft Engineering*, May, 1944, pages 136–138, 7 illus.

Calculations Based on the Bernoulli Pressure Distribution. Max M. Munk. Theoretical two-dimensional wing-section problems are discussed with the aid of mathematical formulas based on the laws governing the distribution of pressure throughout a fluid moving in a steady flow. The use of the Bernoulli pressure in analytical work is explained, together with the reasons why it can be used instead of the velocity potential. The derivation of the equation of pressure distribution is described. Noting that the article is confined to thin wing sections and to two-dimensional potential flows rather than three-dimensional

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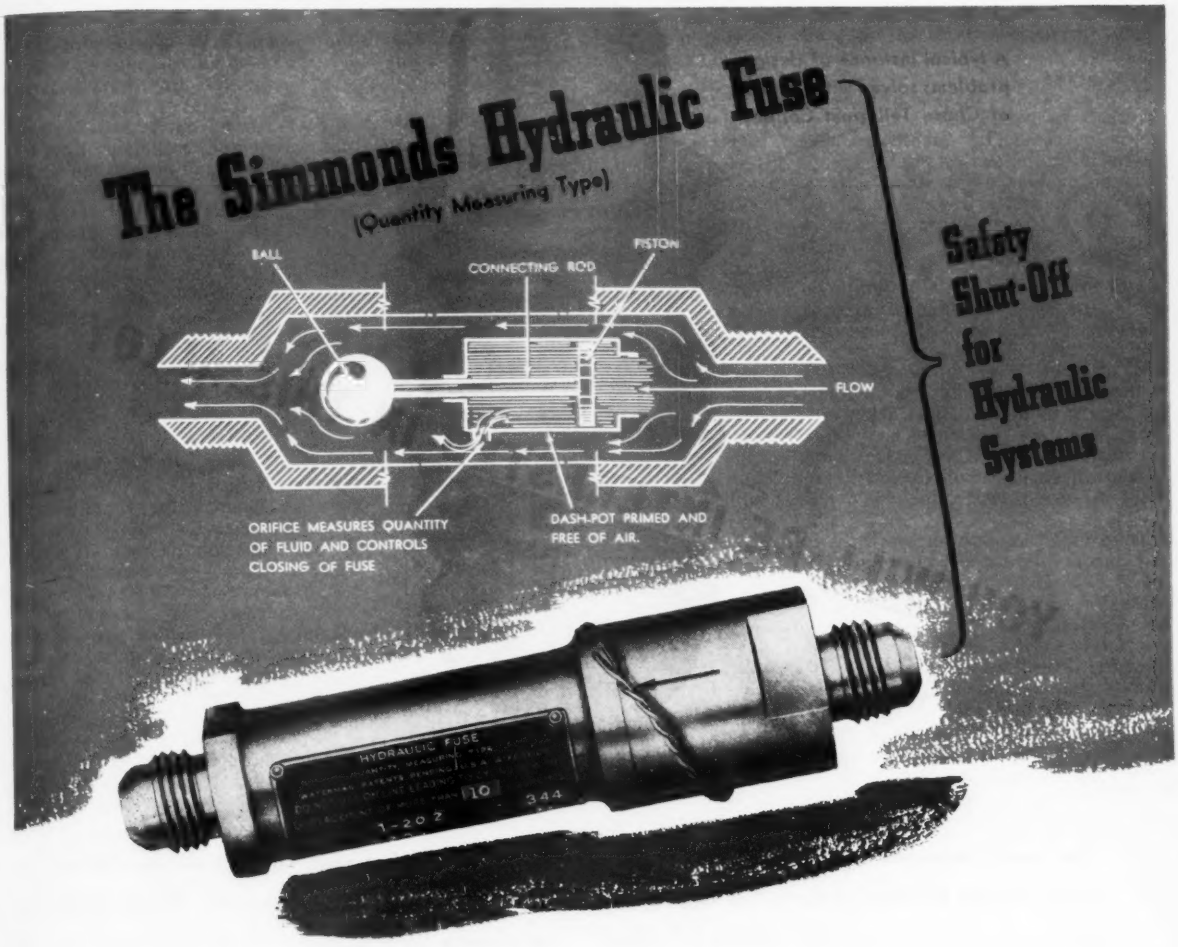

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flows, the writer seeks to find the limitation distinguishing the Bernoulli pressure distributions, or possible ones, from all other pressure distributions.

Three theorems are outlined and each is illustrated by a specific example. Instructions are given for the steps to be taken in computing the velocity components but the solution for the problem is not given because it is stated to require more than ordinary engineering mathematics to do it. *Aero Digest*, June 1, 1944, pages 92, 222. (ED. NOTE—A correction has been published on page 90 of *Aero Digest* for June 15, 1944, referring to equations in the foregoing article appearing on page 222, column 2.)

Air Cargo

Lightweight Stowage for Small Air Parcels. R. B. Evans. A method of handling small packages aboard air cargo planes is suggested. The scheme is based upon the use of webbed-front canvas containers that are sectioned into either four or six compartments. With each compartment holding parcels destined for the same air station, small packages are stowed into this container and the entire unit is hooked to the roof of the airplane during flight. When parcels have to be inserted or removed, only one side of the container is unhooked while the other remains suspended from the ceiling. *Flying*, July, 1944, pages AC-8, AC-9, 5 illus.

A Motor Carrier's View of Air Cargo. Michael H. Froelich. Offering a comparison of truck and air operating problems, a motor-carrier operator maintains that truckers could be of great assistance to the air lines in the development of volume air-cargo business. As told to the writer, a program of collaboration is outlined in which the following points are made:

(1) Truckers have a nation-wide sales force of trained transportation men. (2) They have had experience in packing a diversified list of commodities, including fragile commodities. (3) The job of moving cargo from the airport to the city and the distribution in the city served can be carried out most advantageously by motor truck. (4) Passengers living at a distance from the airports can be best transported to and from the airports by motor carrier. (5) The traffic on certain feeder and secondary lines may not warrant sufficient air trips per day to give adequate service. The motor carrier can supplement air schedules by delivering to and from main-line points. (6) Motor carriers can serve those cities in which there are no air-line stops with cargo moved from the nearest air-line point. (7) In the warehousing of air cargo, many cities will be served best by using several downtown concentration points for the accumulation of shipments and then consolidating their movement to the airport in vehicles making the rounds of the concentration points. *Flying*, July, 1944, pages AC-10, AC-11, AC-23, 1 illus.

Packing Perishables for Air Shipment. Maurice Roddy. Suggestions are given concerning methods of packing flowers and perishable foods for air shipment, types of containers to use, and ways of protecting the commodities during transport. Considerations of air pressure and temperature in the packing procedures are stressed. In advising methods of packing flowers for air transit, the article reports the results of experiments conducted by United Air Lines. It also quotes the views of American Airlines' cargo-traffic manager. Three major reasons are offered in support of the belief that the increasing use of air cargo will bring about changes in packing methods. These are: (1) Shippers will demand packaging that fits the special requirements of air transportation, while taking advantage of the benefits obtainable through air shipping. (2) Since weight is the prime factor in air transportation, the emphasis will be on the greatest possible reduction in tare or container-and-packing weight. (3) Air shipments will not be subjected to as many possibilities for damage as those moved by surface *Flying*, July, 1944, pages AC-20–AC-23, 5 illus.

Air Power

Nippon Teikoku Kugun. George Stromme. This is the first of two articles evaluating the organization, personnel, equipment, and methods of the Japanese air force. In addition to data on the relative strength of the Japanese Army and Navy air forces, Part I contains information about their commissions of rank, training of pilots, equipment, airdromes, bombing assault procedures, flak units, fighter planes, and armament. The general opinion conveyed by the article is that propaganda has greatly overrated the Japanese air forces and that there is little about them that can be considered awesome or formidable. *Western Flying*, June, 1944, pages 46, 47, 112, 114, 120, 2 illus.

Power for Peace. Tom Ashley. Objecting to the inadequacy of a postwar aerial police force with merely reconnoitering powers, the writer presents the basis of a program providing for an American air force that could go into immediate combat action wherever needed. He recommends establishment of major American air bases in the Philippines, Hawaii, Trinidad, Marrakech, and Newfoundland, and indicates how aerial forces operating from these bases could guard the United States against possible aggressive action from almost any part of the world. Emphasis on the mobility of these forces is recommended, while it is demonstrated how the development of long-range bombers would simplify America's defense problems.

The writer also takes into consideration the importance of a national air policy dedicated to the fullest promotion and development of all phases of aviation, with military aviation as the end product. It is his belief that this can be best carried out through the establishment of an independent department of aviation. *Southern Flight*, June, 1944, pages 23–25, 1 illus.

Why Airpower Failed at Cassino. Leonard Engel. The reason given by the writer for the failure of intensive air barrages to achieve decisive results at Cassino is that the barrage improperly preceded rather than accompanied infantry action. It is his point that, in order to be effective, coordination of air and ground forces requires simultaneous action. The separation of barrage and infantry action at Cassino is attributed partly to the fact that few planes of the type best suited for providing a moving screen of fire (such as the North American Invader, the Douglas Havoc, the Hurribomber, and the Mosquito) were available in the Mediterranean theater of war. *Air News*, July, 1944, pages 14, 15, 7 illus.

Air Power in Action. Tom Ashley. Highlights of the air war during the period from April 26 to May 25, 1944, are reviewed. The trends noted include those of the Pacific battle areas as well as western Europe and Italy. The first employment of helicopters in combat aviation, the first United States operation of rocket-firing airplanes against enemy troops, and the first use of antisubmarine rocket guns by United States carrier planes patrolling the Atlantic are reported. Supplementing the article is a tabulation of enemy and Allied losses in the European, Italian, and Southwest Pacific theaters of operations and of enemy losses in the Russian area. *Southern Flight*, June, 1944, pages 52, 54.

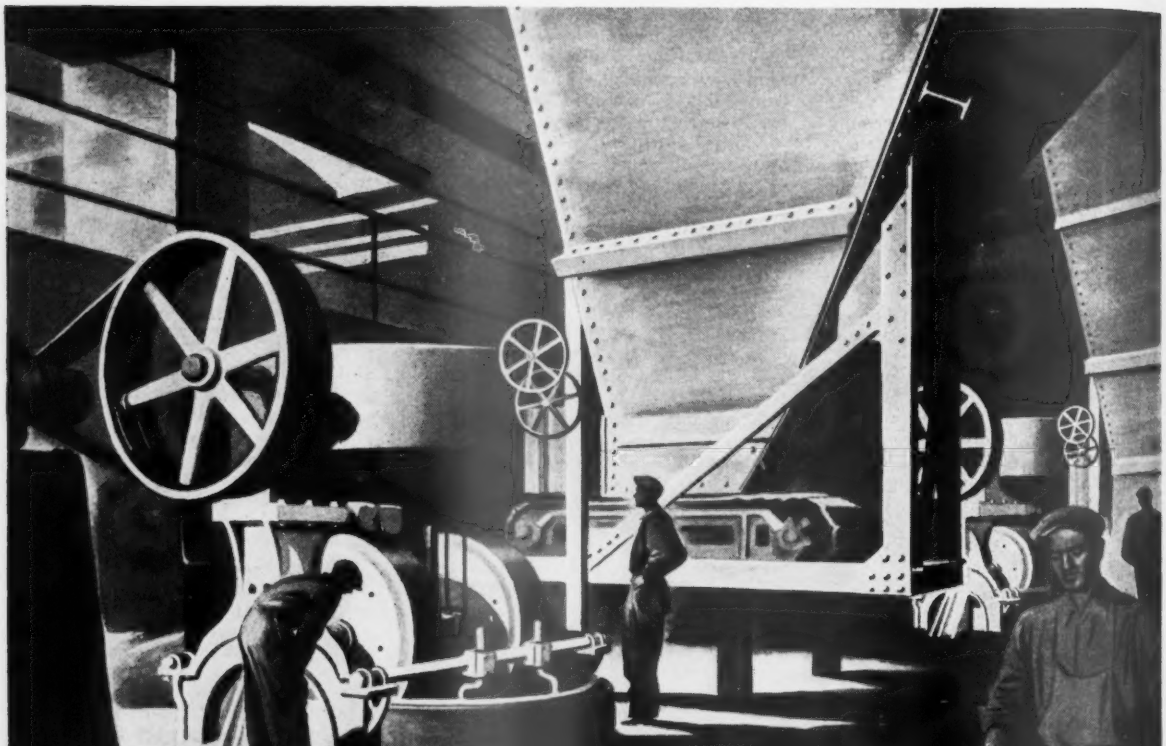
Air Safety

Airline Safety—On the Ground Too. Part II. Jerome Lederer. In this second and concluding article about the way safety for ground personnel may be achieved, the writer tells how accidents can happen. He also describes the organization of an adequate safety system to prevent them. *Air Transport*, June, 1944, pages 41, 42, 45, 46, 7 illus.

Air Transport

I Fly Without Priority. Reviewing the advantages of air transportation over other means of travel, the writer claims that air travel is faster, cleaner, safer, and cheaper even under wartime conditions. He points to his own experiences in being able to make connections without priorities and advises the prospective air traveler not to be stymied by the "priority bogey." *Air News*, July, 1944, pages 55, 56, 36 illus.

Sky Highways? David E. Postle. It is proposed that the present system of civil airways in the United States be eliminated so that unlimited use may be made of ADF (automatic direction finder) procedures for air navigation.



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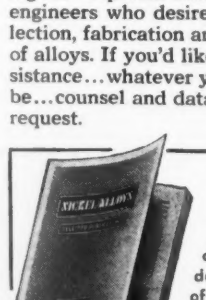

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While civil airways are demonstrated to have certain weaknesses the unlimited use of ADF is said to require no basic control other than flight-altitude separation to prevent aerial collision. The operation of ADF is explained, and its advantages are contrasted with the inadequacies of the present air-traffic control system for handling the volume of commercial air traffic anticipated for the postwar period. *Flying*, July, 1944, pages 21–23, 160, 164, 166, 170, 5 illus.

Organizing for Airline Efficiency. R. Dixon Speas. The third and concluding article of a series on the functions and organizational problems of air-line engineering departments. After discussing the prime purpose of organization, which, it is stated, is establishing efficient "lines" of responsibility and authority, the writer suggests setups for small and large air lines. Organization charts are shown to clarify the discussion. *Air Transport*, June, 1944, pages 38–40, 4 illus.

Tomorrow's Air Transport. Paul Douglas. The Canadian government's decision to build Douglas DC-4 planes, with Merlin engines, as Canada's postwar airliner is criticized. The writer states that Douglas has designed a faster, more powerful transport in the DC-7; that the change in engines makes the Canadian DC-4 an experimental plane; and that the Avro York, which Canadian factories are already equipped to produce, outperforms the DC-4. He also compares the design and performance of the discussed air liner with those of the Lockheed Constellation and the Consolidated Model 39. *Canadian Aviation*, June, 1944, pages 76, 77, 96, 11 illus.

Canada's Air Priority System. E. Fraser. A condensation of the regulations concerning air-transport priorities in Canada. In addition to rules with regard to people who can be granted precedence in air-line travel, the article notes the system of priorities for air express and the absence of priorities on air mail. It also contains data on the procedure for obtaining priorities for American citizens who wish to travel by air in Canada or who want to send air-express packages between the United States and Canada. *Flying*, July, 1944, pages AC-14, AC-23, AC-24, 1 illus.

Governing Principles for Expansion of U.S. Airline System. Part III. Lewis C. Sorrell. The concluding installment of a report prepared for the Air Transport Association and filed with the Civil Aeronautics Board in which broad principles are outlined for the development and control of air transportation on a national scale under Government supervision.

In this installment the writer discusses three types of air transport: one that would serve large cities, an intermediate service, and one for smaller cities and communities in the lower brackets. The third class would be served by connection with the dominant gateway or city in their area, where transfers could be effected with the trunk and intermediate routes. Conclusions reached through the investigation are summarized. *Air Transport*, June, 1944, pages 49, 50, 53, 54.

Airplane Descriptions

The Pilotless Aircraft. Important features of the pilotless aircraft developed by the Germans for indiscriminate attacks on southern England are disclosed in a brief article accompanied by a sketch. The article is based on information from the British Air Ministry and states that this jet-propelled plane is launched from a ramp, probably with the aid of a take-off rocket. It is revealed that the fuselage is 21 ft. 10 in. long with a maximum width of 2 ft. 8 1/4 in., while the overall length of the missile is 25 ft. 4 1/2 in. and the wing span is 16 ft.

The range of the type at present in use is stated to be about 150 miles, the speed in level flight between 300 and 350 m.p.h., and the explosive power equivalent to a 1,000-kg. German bomb. The explosive is carried in the war head, mounted in a thin casing in the front part of the fuselage. The reaction engine is driven by gasoline and the noise heard in flight is caused by intermittent explosions within the jet-propulsion unit. The plane is constructed almost entirely of steel. Control is by an automatic pilot, set before the take-off. *The Engineer*, June 23, 1944, page 491, 1 illus.

The Gloster F.9/37 Two-Motor Fighter. This article contains specifications of and descriptive data on a British experimental fighter model that was not put into production, the Gloster F.9/37. A single-seater, two-engined monoplane, the F.9/37 appeared in two versions—one fitted with two Bristol Taurus TE/Is engines; the other, with Rolls-Royce Peregrine engines. With the former, the maximum speed of this fighter type was 360 m.p.h. at 15,000 ft.; initial climb, 2,030 ft. per min.; maximum rate of climb, 2,460 ft. per min. at 12,000 ft.; service ceiling, 30,000 ft. With the latter, maximum speed was 330 m.p.h. at 15,000 ft. Photographs of the airplane supplement the descriptions. *The Aeroplane*, May 19, 1944, pages 557–559, 6 illus.

Nazi Man Killer. Martin Caidin. In a review of the design, construction, and performance features of the Heinkel 112 and 113 series, the German fighter plane is reported to be even more fatal to the pilots who fly it than to the airmen against whom they fight. An analysis of the plane's landing characteristics explains the reason for this. *Air News*, July, 1944, pages 19–21, 10 illus.

Swedish Air Force Being Strengthened. A brief description is given of a medium twin-engined bomber and a single-seater fighter that have been added to Sweden's military equipment. Both aircraft were designed by Swedish engineers and are completely manufactured in Sweden.

The fighter is of unusual construction. The wings are made of heat-treated wooden squares mounted on a forged-steel framework. It is explained that if the plane is struck by gunfire only the punctured squares have to be replaced. The metal bomber in its latest version has 1,550-hp. in-line engines. The installation of dive brakes enables the plane to be used also as a dive bomber. The organization of Sweden's air force is outlined. *American Aviation*, June 15, 1944, page 36, 2 illus.

Air-Borne by Airspeed. This article deals with the design features and the construction of the Airspeed Horsa transport glider, giving a detailed analysis of how the wings, fuselage, and tail unit are built. In addition, it contains some notes on the executive personnel and future plans of the Airspeed company. Several schematic drawings of components, a cutaway drawing of the entire aircraft, and a list of the glider's specifications complete the article. *The Aeroplane*, May 26, 1944, pages 584–589, 26 illus.

Evolution of the Focke-Wulf 190. Hauptmann Herman. An account of how the Focke-Wulf 190 was developed is supplemented by a detailed analysis of the German fighter plane's features. The specifications to which the FW 190 was built are outlined; a description is given of the B.M.W. 801 engine by which it is powered; and the plane's qualities are compared with those of American and British fighters. Men responsible for the design and construction of the FW 190 are mentioned. The article includes a table of performances and data for this plane and its engine, as well as a schematic drawing of the plane. *Skyways*, July, 1944, pages 24–28, 54, 100, 103, 5 illus.

Allied and Enemy Aircraft in the European War Zone (April, 1944). A tabulation is given, containing the name, dimensions, speed, and recognition features of the aircraft of the Allied nations and of the Axis nations in operation as of April, 1944. The tabulation of the Allied aircraft is divided into two sections: the airplanes are classified according to tactical and strategical air forces' groupings and are subdivided according to type—such as fighters; fighter bombers; light; medium, and heavy bombers, etc. Enemy aircraft is also classified according to type, including the chief combat aircraft, possible secondary combat aircraft, and communications and supply aircraft.

In addition to the tabulation, there are photographs and brief descrip-

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tions of some of the airplanes. *The Aeroplane Spotter*, May 4, 1944, pages 98–107, 138 illus.

Structural Details of the "Conestoga." A group of sectional drawings and photographs illustrating the structural features of the RB-1 Conestoga. These are accompanied by general descriptive data and performance statistics on this troop-transport and cargo-carrier plane. *Aero Digest*, June 1, 1944, pages 80–83, 10 illus.; "Stainless Steel Cargo Plane," *Western Flying*, June, 1944, pages 50, 51, 98, 3 illus.; "The Conestoga—America's First All-Cargo Stainless Steel Plane," *Air Pilot and Technician*, June, 1944, pages 24, 25, 4 illus.; "Ships of Steel," *Air Trails*, August, 1944, pages 22, 23, 90, 4 illus.; "New Budd Steel Cargo Plane Has Many Unusual Features," *Aviation*, June, 1944, pages 186, 187, 6 illus.

Airplanes of the Spanish Army of the Air. Information is given about Spain's military aircraft. A history of the nation's air force is traced and brief specifications are given for the types of airplanes at present believed to be in service, including fighters, bombers, seaplanes, trainers, etc. *The Aeroplane Spotter*, May 18, 1944, pages 114, 115, 8 illus.

The Eshelman Flying Wing. Some brief data are given on the Eshelman flying wing, a design that is about to be submitted for an Approved Type Certificate. The "wing" is described as a four-place cruiser design embodying a conventional tail section. The logged performance, attained with a 235-hp. Lycoming engine, is reported to be: cruising speed 165 m.p.h. with landing gear retracted; range 700 miles, while obtaining 14 miles per gal. with regular aviation fuel; high speed 180 m.p.h. The wing area of the plane is 232 sq.ft., its empty weight is 1,507 lbs., and its useful load is 1,143 lbs. Its service ceiling is 18,000 ft., and the rate of climb is 1,200 ft. per min. *Air Pilot and Technician*, June, 1944, page 18, 2 illus.

Airports and Airfields

Double Nose Hangar Built of Non-Critical Materials. V. C. Lundquist. Details are given on a nose hangar design conceived by Northwest Airlines and used to fill the requirement for an easily and quickly constructed structure. Built entirely of wood, the hangar is of cantilever type with openings at both ends into which the fuselages of two planes can be placed while their tails protrude outside the shelter. The open ends of the building are closed off by means of canvas curtains and the interior is heated by unit hot-air furnaces. A central passageway through the hangar permits the use of a tractor for pulling large planes into the enclosures. *Flying*, July, 1944, pages AC-12, AC-13, 4 illus.

Setting the Sights. An outline is given of the way to make a rough estimate of the cost of building a small airfield. A chart contains data compiled to aid the small town in estimating how much it will have to spend to build a single-strip airport, paved or unpaved. Drainage, topsoil problems, and other items are discussed. *National Aeronautics*, June, 1944, pages 20–22, 1 illus.

The Boeing B-29 Superfortress shown during a flight near the Boeing Aircraft Company's plant in Seattle, where the giant ship was originated and developed and where the first experimental models were built.

Observations on Airport Construction. Part II. Bernard E. Gray. The second of two articles on airport design and construction outlines procedures to follow in the use of asphalt for construction, maintenance, and rebuilding of runways. It also summarizes some of the major factors to be considered in the building of an airport. These are set forth under six items: (1) For a long time to come airports capable of carrying 60,000-lb. wheel loads will be adequate. (2) Airports cost so much that initial studies of the soil strata, including field bearing tests, both on the subgrade and upon trial sections of pavement, are thoroughly justified. (3) More attention should be given to drainage. (4) So far as possible, load support should be obtained by the construction of bases and subbases employing locally available aggregates. (5) The paving procedure selected should take account of meteorologic conditions. (6) The reconstruction of many existing airport surfaces to take greater wheel loads will be an early necessity, and decision must be made whether to rebuild entirely or to salvage the present pavement. *Flying*, July, 1944, pages AC-16–AC-18, 5 illus.

Armament

Target Practice for a Blitz. The miniature $11^1/_2$-lb. practice bomb used for teaching Royal Canadian Air Force cadets the science of aerial bombardment is described. It is explained that the bomb is a cartridge type that was developed to replace the conventional acid-type bomb. The cartridge contains a smoke-producing explosive and has a cellulose-acetate head and tail cap. The design and assembly of the cartridge are described. *Modern Plastics*, June, 1944, pages 98, 99, 5 illus.

Curve of Pursuit. Gaither Littrell. Based on information gained from a visit to gunnery camps of the A.A.F. Western Flying Training Command, this article explains the theory of aerial gunnery underlying the technique of American airplane gunners. The nucleus of the theory is that attacking fighters must approach their target aircraft on a fixed line of flight.

As outlined in the article, the technique follows these principles: (1) The only fighter in which the defending gunner is interested is the one bearing down directly on his plane. This also is the enemy fighter that is easiest to hit, despite the fact that in the gunner's ring sight it may appear in, or nearly in, a head-on position. (2) The attacking fighter must fly a fixed curved line of pursuit to hit the bomber. (3) The gunner does not always aim ahead or lead the target. Instead, he more often aims between the fighter and the tail of his own plane. (4) In making its approach, an enemy fighter, no matter from which point he attacks, must come in on the gunner's plane at one of a number of previously calculated angles. These angles form cones of fire. In position firing, the gunner is taught the proper sighting angles for each of these cones.

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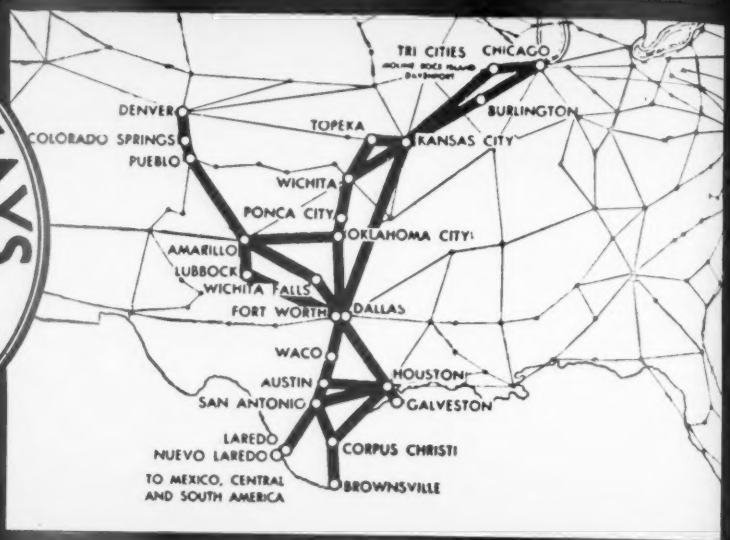

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AVIATION GASOLINE

The article also describes some of the training aids employed at the gunnery camps and includes data about the use of the Sperry computing gun sight. *Flying*, July, 1944, pages 56–58, 152, 154, 8 illus.

Bomb Bakery. A group of photographs illustrates the bomb-loading activities of the Nebraska Ordnance plant, operated for the Government by the Firestone Tire & Rubber Company. Some of the precautions taken to safeguard employees against the hazards of handling these bombs are noted. *Western Flying*, June, 1944, pages 48, 49, 7 illus.

Avigation

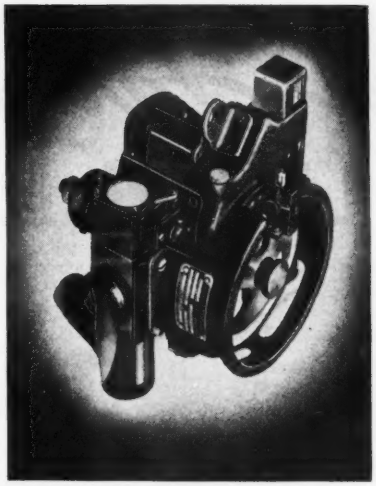
So You're Afraid of Fog. Victor Boesen. This article deals with the radio devices that have overcome the problems of piloting aircraft through fog. Besides offering some brief details on the fog-avigating devices that preceded the radio beam, it explains how airplanes are guided along a fixed course by the radio beam. It also tells how blind landings are made possible by radio and describes the operation of the automatic direction finder. In conclusion, the article indicates the potentialities of radar for making flight through fog safe. *Skyways*, July, 1944, pages 38, 39, 78, 80, 1 illus.

Groundwork for a New Interpretation of the Problem of Air Navigation. Part 2. Tappan Collins. The second of a series of articles in which the writer suggests a new system of instrumentation for air navigation. His theories of the kind of system that is needed are based upon the concept of air navigation as a problem of compound rotations. In Part 2 he continues his explanation of "Flight Kinemetrics," the suggested scheme for measuring the motion of flight. He also describes an indicator that could be utilized for "Flight Kinemetrics." This indicator is a single-dial type showing changing position against a conventionalized background, without reference to compass or chart. *Aero Digest*, June 15, 1944, pages 56–58, 140, 4 illus.

Business and Finance

Are Airline Stock Values Real? Raymond L. Hoadley. Investors in securities of air lines are warned of the many problems facing air transport companies in the immediate postwar era which may adversely affect stock-market prices. Probabilities of declining pay loads, increased investments in flying equipment, and difficulties in adjusting operating costs of new "superliners" are examined. The writer points out that under peacetime conditions shippers may give greater consideration to the lower rates charged for railroad, boat, and bus transportation. *Aviation*, June, 1944, pages 135, 251, 253, 1 illus.

Fly-Yourself is Big Business. Howard Ailor. The writer discusses some of the problems involved in operating



The Fairchild Camera & Instrument Corporation's model A-10 aircraft sextant.

a "fly-yourself" business and indicates that it is a venture that requires substantial financial backing. He estimates the amount of capital and equipment necessary for conducting such an operation and lists the auxiliary services that should be coordinated with it in order to establish its profit possibilities. These services are aircraft sales, airplane overhaul and maintenance, sales of accessories, and charter work. The writer also gives his opinion as to the cost of operating a fly-yourself chain of bases. It is his belief that the minimum capital required for conducting a network of 100 bases would be $10,000,000. *Aviation*, June, 1944, pages 184, 297, 1 illus.

Civil Aviation

Cubs vs. Coyotes. Alma Johnson. An account of how Civil Air Patrol planes are instrumental in saving livestock from marauding coyotes. The preying animals are spotted from low-flying Piper Cub airplanes and shot by gunners who accompany the pilots of the two-passenger aircraft. *Southern Flight*, June, 1944, pages 26, 27, 2 illus.

Control Equipment

Automatic Flight and Airplane Stability. Stephen J. Zand. In a review of the factors affecting airplane stability as a governing element in the design of automatic flight-control instruments, the Director of the Vose Memorial Laboratory of the Sperry Gyroscope Company begins with a statement of the problem to be attacked. He defines static and dynamic stability, tracing the work of numerous scientists in bringing the problem of dynamic stability progressively closer to practical engineering solution. He comments briefly on the theoretical and practical work involved in making the mathematical calculations required, setting up the basic equations, and explaining their solution and ways to simplify them.

The next steps are to find means to prevent the generation of the natural oscillatory motions of the airplane which tend to divert it from the desired trajectory and to create an instrument to give a "signal" as soon as that impulse is created. The characteristics of such a signal are defined, and it is shown how gyroscopes serve the purpose. Omitting the details of the construction and operation of the amplifying, transfer, and servo mechanisms used to transmit the impulses arising in the gyroscopes, the writer gives a simple example of the operation of an automatic pilot. The disturbing forces acting on the airplane and the follow-up operation of the instrument are analyzed.

Having discussed only the motions of the airplane about its center of gravity, the writer next considers motions of the center of gravity itself, for which another series of signals is added to those which detect changes in angles, and a further expression is added to the follow-up equation. Other variations and supplementary mechanisms to accomplish desired changes in the flight path are mentioned, as well as modifications by which the instrument can be made to respond to the will of the airman and to outside influences such as landing beams and radio direction signals. In conclusion, the writer praises the accomplishments of the engineers who solved the problems of design and production of the automatic pilot, and notes the advantages offered by that instrument. *Aviation*, June, 1944, pages 140, 141, 290–293, 295, 296, 2 illus.

Design

Theory of the Centrifugally Tuned Vibration Absorber. Ralph J. Harker. This investigation is primarily concerned with the performance of an idealized centrifugally tuned pendulum at the condition of maximum response of the main system on which it operates. It is therefore possible to dispense with the consideration of the response curve as a whole by focusing attention on the peak, which is the singularly important point. Calculations are made which show the effect of tuning, damping, and mass ratio upon absorber characteristics at the peak frequency, providing a rational basis for design and the interpretation of test results.

The absorber is found to produce maximum reduction in vibratory amplitude when there is minimum absorber damping, minimum main system damping, optimum tuning, and maximum mass ratio. Optimum tuning is slightly less than exact and is a function only of mass ratio. Relative motion of the absorber is a minimum at optimum tuning, and at this condition the motion is practically independent of absorber damping. The frequency at which maximum motion occurs in the response curve of the main system is always de-

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creased if the absorber is "overtuned" or if the tuning is optimum or exact; however, the peak frequency may be increased or decreased by an "undertuned" absorber, depending on the extent of off-tuning. A chart is presented by means of which the main system response peak frequency and amplitude can be determined for any combination of absorber tuning, damping, and mass ratio. *Journal of the Aeronautical Sciences*, July, 1944, pages 197–204, 246, 15 illus.

Radiant Energy Exchange as a Factor in Airplane Cabin Heating. B. F. Raber and F. W. Hutchinson. Accepted ideas of comfort, as evidenced in convective heating systems of conventional design, are not applicable to the problem of establishing occupant comfort in an airplane operating at great elevation. By setting up a heat balance on the occupant, an approximate "comfort equation" is established which is suggested as a criterion for the design of heating systems for airplane cabins.

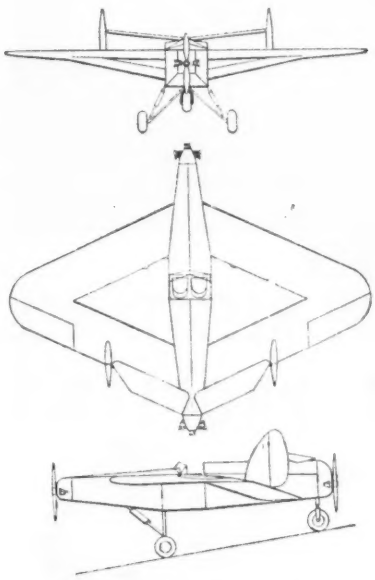
Panel heating is discussed as an alternative method of meeting the special problems of aircraft heating design, and equations are developed for calculating the interception of radiant energy, by an occupant, from panels located in various positions.

Solution of the fundamental radiant exchange equation is discussed in terms of uniformity of heating effect and compensation for extremes of "spot" surface cooling. The intent of the paper is analytical rather than descriptive, but sufficient equations and references are given to permit the designer to apply the radiant exchange method to practical aircraft heating problems. *Journal of the Aeronautical Sciences*, July, 1944, pages 239–246.

Rhombic Ruminations. Norman Hall Warren. The aerodynamic and structural characteristics of the Warren-Young tandem monoplane are analyzed and an explanation is given of the principles upon which the design is based. Developed with safe-flying characteristics as the primary consideration, it is reported that in this aircraft the sudden stall is eliminated and stability in pitch and roll is achieved. The principles upon which these properties depend derive from the characteristics of swept-back and swept-forward airfoils and also from the effects of two airfoils operating in tandem. As shown in a general-arrangement drawing, this airplane project provides for a wooden-construction, two-seater, twin-engined model of about 90 hp. The two engines are installed in a fore-and-aft arrangement, one at each end of the airplane. *Flight*, May 18, 1944, pages 526, 527, 3 illus.

Analysis of the Possibilities Presented by Hydrofoil-Equipped Aircraft. Herbert A. De Cenzo. A detailed examination of the advantages and disadvantages of hydrofoil-equipped aircraft. The merits of what the writer calls "hyplanes" are analyzed on a comparative basis with those of landplanes, seaplanes, and flying boats. As evolved from a model described in *N.A.C.A. T.M. No. 691*, a design for a fighter plane equipped with hydrofoils is suggested. In considering the problems affecting hydrofoil design, the possibilities of their application to flying wings and jet-propelled aircraft are investigated.

From the results obtained in this analysis, the flight performances of the landplane, the hydro-equipped airplane, the flying boat, and the seaplane are rated in the order named. The conclusions offered include the prediction that most of the long-range, heavy load carrying airplanes of the future will be jet-propelled hyplanes. Four tables supplement the article. The first is a comparison of fighter performance in landplanes, hyplanes, and seaplanes; the second shows the major items causing weight differences in the flying boat, the flying wing, and the hydrofoil-equipped flying wing; the third lists the comparative twin-engined performance of an all-wing landplane, all-wing hyplane, and a conventional flying boat; and the last offers a comparison of the performance of four-engined all-wing landplanes, all-wing hyplanes, and conventional flying boats. *Aero Digest*, June 1, 1944, pages 70–72, 128, 130, 4 illus.



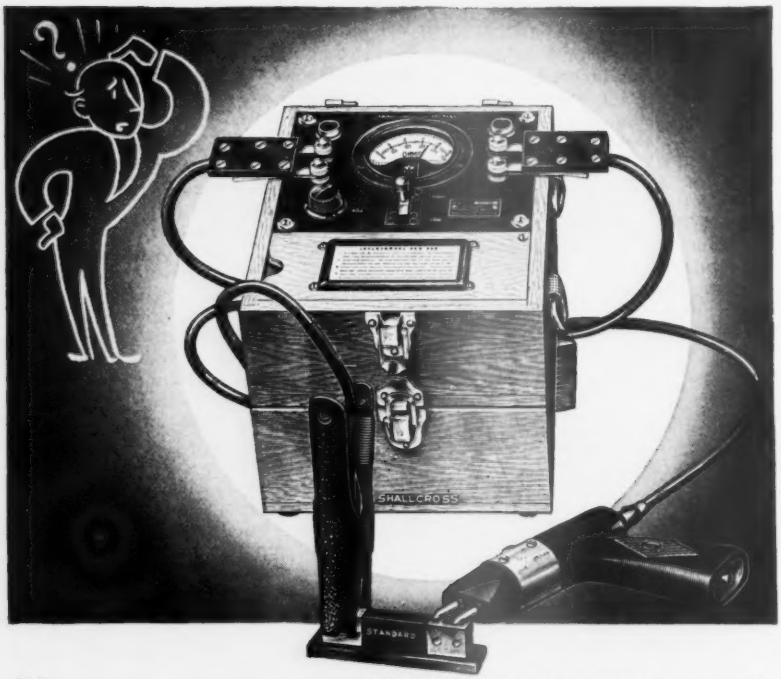
Photograph Courtesy of Flight *Magazine*
The Warren-Young tandem monoplane.

What Avenue of Development? Keith Ayling. Possible avenues of future aircraft development are considered. It is stated that there is a possibility that the conventional form of airplane may have reached its limits in speed, range, wing loading, and altitude. Various types of so-called "unconventional" aircraft and their future possibilities are outlined. The flying wing is reviewed with regard to what has been done in the development of this type of aircraft. Tandem planes, asymmetrical planes, jet-propelled aircraft, and helicopters are discussed. The future development of aircraft power plants is also investigated. *Aircraft Age*, August, 1944, pages 14–16, 52, 53, 10 illus.

Vibrations in Aircraft. Part IV. Conclusion: Effects of Vibration and Practical Methods of Treatment. R. G. Manley. This is the fourth and concluding article of a series on the general principles of vibration in aircraft. The effects of vibration are summarized, and practical methods of preventing large vibrations in aircraft are considered. It is noted that the two main effects of vibration are discomfort and danger. The aircraft structure itself is capable of vibrating in a large number of complicated modes or patterns, each associated with a particular frequency. Vibrations of sufficiently large amplitudes to become unpleasant or even dangerous can therefore be caused by imposed vibratory forces at various frequencies corresponding to the natural frequencies of the structure, the large amplitudes resulting from the magnification effect of resonance. The excitation of these modes, in which the whole aircraft participates, originates in the power plant. Unbalance in the propeller and unbalanced forces and moments in the engine are the immediate cause and are transmitted through the engine mountings to the air frame. Mounting schemes that have been developed in the attempt to isolate the power plant from the rest of the system are discussed. *Aircraft Engineering*, May, 1944, pages 133–135, 4 illus.

Control Surface Balance Weights. Edward S. Fife. The calculation of the balance weights required to control flutter in airplane control surfaces is discussed. It is noted that a study of control surfaces of the past reveals lack of sufficient attention to design. The ideal design for a control surface is outlined. Symmetrical, piano-hinge, and Frise-type aileron sections are considered. It is pointed out that the Frise type requires the least amount of balance weight, since the large portion of the structure is ahead of the hinge line, while the type incorporating the piano hinge requires the greatest amount of balance weight because no portion of its surface is forward of the hinge. The writer discusses the problem of determining aerodynamic balance, which, it is noted, is given in per cent and represents the ratio of the area forward of the hinge line to the total area. He then discusses the static and dynamic balancing of control surfaces. *Aero Digest*, June 15, 1944, pages 96, 98, 130, 4 illus.

DeHavilland "Mosquito." Part II. Chester S. Ricker. Part II is a comprehensive study of the de Havilland Mosquito's design and construction. Having discussed the air frame in Part I, the writer concludes the analysis with details on the landing gear, hydraulic and pneumatic systems, and controls. Particulars of the following are examined: flaps, ailerons, stabilizer, ele-



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vators, tail fin, rudder, landing gear, shock-absorber strut, landing wheels, and brakes. Other components that are described at length are the wheel doors, tail wheel assembly, engine cowling, engine controls, mounting, fuel system, elevator control, a leron control, rudder controls, and oxygen system. Numerous schematic drawings supplement the study. *Aviation*, June, 1944, pages 123–137, 24 illus.

A Generation of American Fighters. Part I. Lt. Peter Bowers. The evolution of American fighter-plane design is traced from the fighters of World War I through the P-30. Data are given on fighters that filled the gaps between announced plane designations, as well as those that were put into quantity production. *Air News*, July, 1944, pages 42, 43, 68, 6 illus.

Calculation of the Turning Radius of an Aircraft. Norman N. Rubin. To provide a convenient means of determining the turning radius of aircraft, the writer adapts Oswald's calculation of the power required to Diehl's method and utilizes a simplifying chart of the load factors imposed by centrifugal force. *Aero Digest*, June 15, 1944, pages 116, 117, 5 illus.

Electrical Equipment

Present D-C Aircraft Electric-Supply Systems. H. C. Anderson, S. B. Crary, and N. R. Schultz. This paper deals with the type of multi-generator d.c. electric system at present used by the multiengined Army type of airplane. Emphasis is placed on the performance of the system rather than on developments in progress. The writers discuss details of performance, the significance of which has been enhanced not only by present military use but by the possible adoption of a similar system for commercial aviation in the postwar period and for d.c. systems more generally. *Electrical Engineering*, June, 1944, pages 265–272 (Transactions), 17 illus.

Computing Short-Circuit Currents and Interrupting Capacities. Wayman A. Holland. A simple method is outlined for calculating the short-circuit current and interrupting capacity of an electrical system. The first step shows how to ascertain the total reactance to the point of the fault; the second, how to find the symmetrical short-circuit current by dividing the normal base current by the total "per-unit" reactance; and the third involves the total asymmetrical short-circuit current. The contributions of the following to the computations are explained: "per cent" and "per unit" terms, conversion to base kva., conversion of ohms motor contributions, fuses (15,000-volt and below), low-voltage air circuit breakers, and power circuit breakers. A table lists the multiplying factors and apparatus reactances to use for interrupting-device selection. *Aero Digest*, June 1, 1944, pages 96, 97, 1 illus.

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DEVELOPING · DESIGNING · MACHINE WORK · SPINNING · WELDING · STAMPING · FINISHING

Engines

Design Craftsmanship Cuts Engine Production Costs. H. S. Golden. Several instances are related in which the Buick Motor Division of General Motors Corporation reduced production costs or avoided service troubles by instituting minor design changes for the manufacture of Pratt & Whitney aircraft engines. The alterations described pertain to fins around spark-plug openings, intake pipes, fuel pump couplings, reduction drive-gear couplings and nuts, cylinder-bore choke dimensions, oil-control rings on pistons, compression rings, bolts, and oil pipes. *Aviation*, June, 1944, pages 150, 151, 269, 10 illus.

Combating Vibration in Aircraft Power Plants and Their Mountings. T. D. Copeland and Gordon Getline. A detailed description is given of how some actual vibration problems in aircraft power plants were effectively solved at the Wright Field aircraft laboratory. One case was that of a small two-place monocoque training plane in which power-plant vibration caused structural failure of the air frame, cracking of the fuselage skin, and shearing of rivet heads. Another problem was a vibration condition in a large modern multiengined airplane in which vibration was so severe that generators and starters were loosened at their mountings. The tests are described.

It is stated that the first step is discovering the vibration problem either by tests for this purpose or by evidence of its damaging effect; the next step is to perform tests for the classification and measurement of the vibration; and the final step is to devise corrective measures from examination of the results of these tests. *Automotive and Aviation Industries*, June 1, 1944, pages 22–24, 67, 70, 7 illus.

New System Simplifies Engine Cleaning. T. J. Kearney. A system for cleaning engine parts preparatory to overhaul is detailed. Minimizing the need for hand work, this scheme incorporates the use of a conveyerized washer and other assembly-line methods. Particulars are given on the cleansing agents employed for the various operations, as well as on the machines that are utilized. Three tables list the required physical properties of the solvent, commercial stabilized trichloroethylene; properties of cresol-base cleaning compound; and properties of the specified emulsion. The illustrations include a diagram of the multiple-stage washer and a layout of an aircraft-engine disassembly and cleaning shop, showing sequence of operations. *Aviation*, June, 1944, pages 161–164, 9 illus.

The Napier Sabre Engine. Part III: Sub-assembly and Final Build; Balancing the Impellor Unit; Supercharger and Engine Testing. J. A. Oates. This concluding article deals with various stages of fabrication, assembly, balancing, and testing procedure. It touches upon the operations of each of the six main departments of the assembly shop, comprising subassembly first-build, engine first-build, engine strip and subassembly rebuild after test, engine rebuild for final test, packing and dispatch, and special work and building for retests. Details are given about the inspection for gear backlash, gear-carrier liners, balancing equipment, outer cone assembly, removal of metal, lapping spherical seats, and calibrating lubricant jets. Other information pertains to the testing of oil passages, timing the port openings and balancing the sleeves, supercharger testing, first-build operations, special assembly equipment, production testing, stripping, and final testing. *Aircraft Production*, June, 1944, pages 280–289, 28 illus.

Automatic Clearance Regulators for Poppet Valve Mechanisms. Otto M. Burkhardt. Some of the weaknesses in internal-combustion engine valve linkage are discussed. Consideration is given to the effects of valve-linkage clearance, yield in the valve linkage, and cam ramps. It is stated that changes in the velocity of the valve because of yield became more serious in push-rod operated valves used in aircraft engines. Reasons for the deviation of the actual from the theoretical valve motion are discussed in some detail. Possible remedies for the trouble are examined. Specialized cam contours, the application of aperiodic acceleration, and the use of automatic valve adjusters are considered. The requirements for an automatic clearance regulator are outlined. *Automotive and Aviation Industries*, June 1, 1944, pages 30–33, 72, 74, 76, 8 illus.

Operation and Servicing of Zero-Lash Valve Lifter. Exemplified by an installation in the Franklin aircraft engine, the purpose and operation of the Zero-lash hydraulic lifter is explained with the aid of a diagram. Suggestions are also given on methods of forcing oil from the lifter and for making rocker adjustments. *Aviation*, June, 1944, page 165, 3 illus.

Aircraft Engine Lubrication. Problems in connection with the efficient lubrication of aircraft engines are discussed. Consideration is given to the properties of oils suitable for the purpose. It is noted that the theory of correct lubrication calls for the use of as thin an oil as will stay in place and maintain a film with a reasonable factor of safety, but that if such a light oil were used in aircraft engines it would pass by the pistons in large quantities because of the greater piston clearance required.

The specifications for aircraft-engine oils are outlined. Variations in lubrication requirements for different types of engines are referred to, and illustrations are furnished of the lubricating systems of the Wright Cyclone, Packard-built Rolls-Royce, Allison, and Pratt & Whitney Twin Wasp engines. *Air Tech*, July, 1944, pages 30–33, 68, 4 illus.

Cylinder Arrangement of 4000 Hp. Aircraft Engines. Part I. A discussion of problems involved in the design of aircraft engines of large output with particular regard to cylinder arrangements of from 30 to 48 cylinders. This is the first of a series of articles based on a study published in the German periodical *Luftwissen*. A 4,000-hp., four-stroke, spark-ignition engine is used as an example, but the conclusions are formulated in such a way that they are applicable generally to engines of both lower and higher output.

Three methods by which a compact layout can be obtained when an aircraft power plant of large output is being designed are outlined as follows: (1) by developing existing single-shaft engine types to the required higher power by increasing the number of cylinders, the b.m.e.p., and the piston speed; (2) by obtaining the total power required from a number of separate power plants; (3) by combining a number of engines into separate power units by means of suitable gear or flange couplings. Consideration is given to the number and size of the cylinders. The relationship between the cylinder bore and the specific weight is investigated on the basis of statistical data. Crankshaft layout and its relation to the propeller-drive problem are discussed. Other sections are devoted to considerations of speed reduction and power distribution. *Automotive and Aviation Industries*, June 15, 1944, pages 36–40, 42, 15 illus.

Progressive Line Methods Expedite Engine Overhaul. J. R. Horton. The Embry-Riddle Company's system of engine overhaul is outlined. With data given on the procedures and machinery used, the sequence of overhaul operations is traced from the time the engine is uncrated and routed to the precleaning booth until it is placed, in perfect condition, in pliofilm envelopes ready for storage or return shipment. *Aviation*, June, 1944, pages 172–175, 11 illus.

Flight Testing

Flight Testing Methods. E. T. Jones. In this extensive article on methods of flight testing the writer outlines the scope of the flight tests considered. The tests required to establish flight performance and behavior within the scope of the project are described and listed in tabular form. The subject is discussed at length in sections dealing with complementary tests, performance and allied quantitative measurements, flight characteristics, and miscellaneous tests.

The closing sections of the paper discuss performance-reduction methods, and developments in prototype testing. Appendixes contain information regarding air measurements in flight, design features of the improved F.47 take-off camera, and additional engine-cooling tests supplementing those previously standardized. *The Journal of The Royal Aeronautical Society*, May, 1944, pages 99–158, 26 illus.

ON LIGHTER, STRONGER TIRES

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HOW THE NAVY HELPS BUILD LIG

Reporting the Problem

Official U. S. Navy Photo

A Navy Grumman Hellcat fighter comes in for a landing on a first line aircraft carrier operating in a Pacific Fleet task force.

NAVAER - 4112

STATEMENT OF TROUBLE

...Tires are blowing out under impact of deck landing, causing sev-

Official U. S. Navy Photo

A THOUSAND-POUND BOMB is loaded on a Navy Douglas Dauntless dive bomber about to take off. This added fighting power is another reason why the Navy's tires must be strong to carry the load and light to keep down weight.

Even with the most exacting care in specifications and manufacture of airplane tires and tubes, combat conditions often develop weaknesses that must be corrected; improvements that should be made to give our fliers greater effectiveness and greater safety. Through reports from combat zones called R.U.D.M. (NAVAER-4112) the Navy Bureau of Aeronautics at Washington is kept constantly in touch with all problems. When these reports are received, they are immediately relayed to all interested suppliers for quick action.

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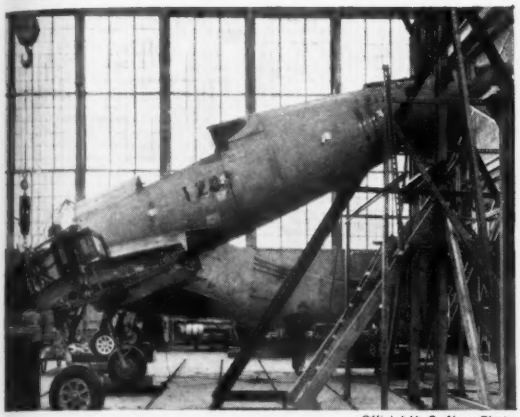
LD LIGHTER, STRONGER, SAFER TIRES

Finding the Answer

Not only does the Navy send its various suppliers performance reports direct from combat areas but it also constantly conducts its own laboratory and service tests. All findings that will assist manufacturers in improving their products are sent on to them for study. In this way, the technical staffs of industry benefit from the Navy's testing program just as industry's research serves the Navy.



Official U. S. Navy Photo

DROP TEST—At one of the test laboratories of the Navy Bureau of Aeronautics, landing wheels are "drop tested" on a rig like this. Here a set of landing wheel tires is mounted on the rig and dropped under full load simulating landing impact.

Official U. S. Navy Photo

DECK TEST—Actual service tests carefully supervised by Navy engineers show how the product stands up in service. On tests like this, U. S. Royal Airplane Tires—and tires of all other suppliers—must prove their ability to "take it."

Official U. S. Navy Photo

BATTLE TEST—The toughest test of all is the battle test where all rules are off—where the most extreme condition may be met, where loads are heavy and speeds are high. All the testing, all the checking, all the reporting of problems wherever they occur are parts of the Navy's precept and practice—"never waste a life."

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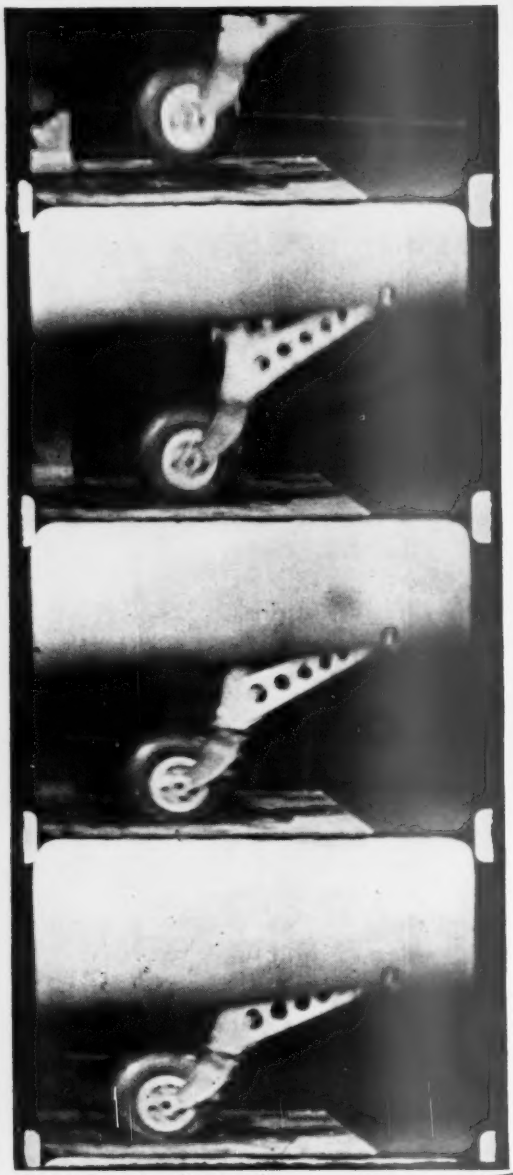

Official U. S. Navy Photo (Unretouched)

Slow motion picture

OF A NAVY FIGHTER SITTING DOWN!

This is an unretouched motion picture taken in the Navy's own testing laboratory showing what happens when the tail assembly of a Navy fighter "sits down" on a carrier deck. (Carrier landings are tail first, of course.) Under full load, the tail wheel tire strikes the landing strip and squashes almost flat under the impact. Tests like this show why tail wheel tires must be built with extra strength, extra stamina to stand the bruising "sock" of carrier deck landings.

The tests described in these pages are examples of the vision of the leaders of all our Armed Forces in providing our fighting men with the most effective fighting equipment that modern science can devise.

U.S. Royal Airplane Tires for landing wheels, tail and nose wheels, and for beaching gear are available in all standard sizes in smooth contour and high pressure types. For complete data book including full page deflection charts write on your business letterhead to United States Rubber Company at address below.

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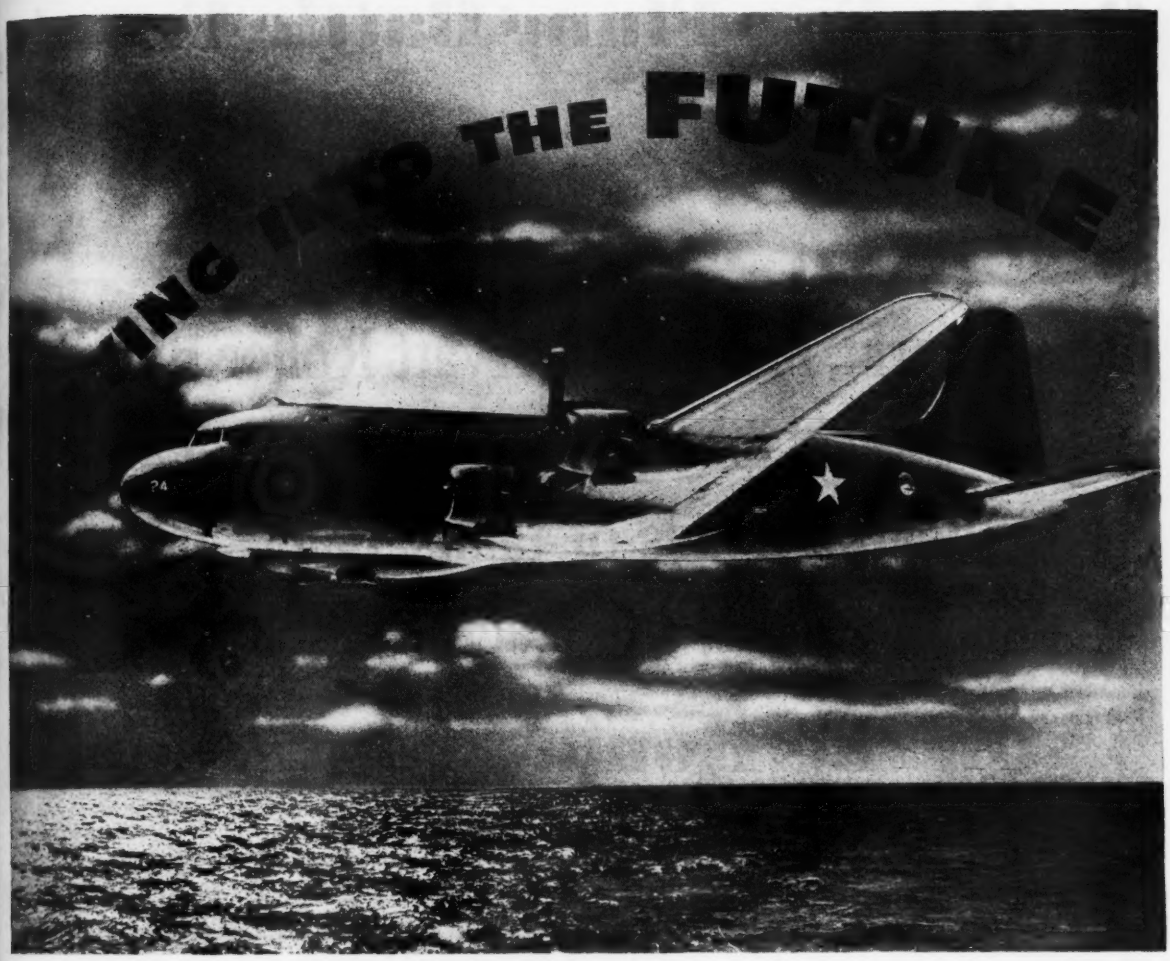

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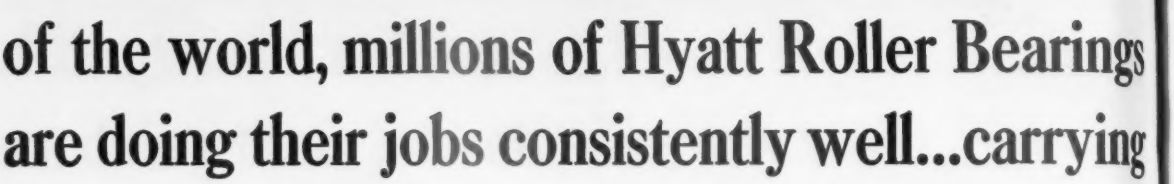

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Gliding and Soaring

The Temperature Gradiometer for Soaring. August Raspet. In this paper the history and technique of temperature gradiometry are outlined. The writer shows how a temperature gradiometer may be used to locate the center of a thermal and to give a measure of the strength of the thermal. The instrumentation involved in these measurements is described. An outline is given of the way the apparatus has been improved to make it a sensitive instrument capable of extending soaring beyond the flight-by-feel stage. *Soaring*, January-February, 1944, pages 1–3, 10, 12, 11 illus.

And What of To-Morrow? Sailplane Pilot. The possibilities of sailplaning (or gliding) for fostering a love of aviation among the British people are extolled. It is stated that sailplanes offer a much cheaper means of flying for sport than airplanes and that promotion of this activity would put aviation within the grasp of greater numbers of people. Conditions upon which soaring flight depends are outlined. *The Aeroplane*, May 19, 1944, pages 562, 563, 4 illus.

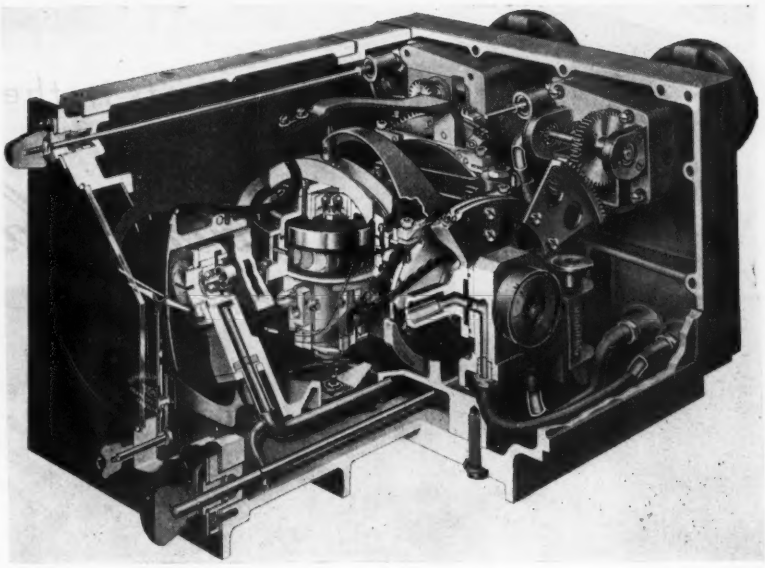
Vee Tail. Robert M. Stanley. A description of experiments conducted with a glider equipped with a Vee tail instead of the usual empennage. Eight advantages that are stated to be obtained with the Vee tail are enumerated. *Soaring*, January-February, 1944, pages 6, 7, 2 illus.

Cadet UT-1 Glider. Alexis Dawydoff. A description is given of the Cadet UT-1 glider, an American version of the British Kirby Cadet, a secondary trainer designed and built by Slingsby Sailplanes, Ltd. The specifications of the UT-1 are listed, and its performance is described by the builder. *Soaring*, January-February, 1944, pages 8, 9, back cover, 5 illus.

History

Flying as It Was. Allan H. Lockheed. Some recollections by Allan H. Lockheed of his aviation career and of developments that took place in the industry from 1910 to 1934. Starting with the story of how he learned to fly in 1910, he tells of the first plane he built in 1912, his passenger-carrying concession in 1915, and the beginning of the Lockheed factory. As indications of the general trend in airplane development, he notes the advent of the Lockheed F-1, the S-1 (described as the first plane to have a two-piece streamlined, molded plywood fuselage skin), the Lockheed Vega, and the Lockheed Electra.

Famous air voyages made in the Lockheed Vega are noted and planes by other designers are mentioned. The latter include the Sikorsky S-40 amphibian and the twin-engined Boeing 247. *Air Pilot and Technician*, June, 1944, pages 11–13, 7 illus.



Bank and climb control unit of the Sperry Mark III automatic pilot, which controls aileron and elevator movement when airplane is under the control of the automatic pilot.

Hydraulics

How Hydraulic Controls Operate. John Sasso. This article defines and describes the component parts of aircraft hydraulic control systems and explains how they function. It is written as an aid to the mechanic who is taking up this type of maintenance work. *Air Transport*, June, 1944, pages 57, 59, 62, 65, 67, 69, 29 illus.

Maintenance of Typical Hydraulic Equipment. Raymond N. Greif. Advice is offered on procedures for servicing the various parts of hydraulic systems. As a guide for the maintenance of any type of hydraulic equipment, ten general precautions are listed. These rules are followed by more specific suggestions for treating leakage troubles in actuating cylinders and relief valves. Correct methods of disassembling, checking, and readjusting these typical hydraulic mechanisms are outlined. *Aero Digest*, June 1, 1944, pages 78, 79, 3 illus.

Inspection

Defects in Light-Alloy Sheet and Strip. Following a brief outline of inspection practice for light-alloy sheet and strip designed principally for aircraft applications, the writer makes a detailed analysis of surface defects, their causes, prevention, and cure. Sections of the article define and discuss blisters, spill, gags and splits, rolled-in dirt, drags, corrosion, mechanical damage, buckles, overheating, and miscellaneous defects. *Light Metals*, June, 1944, pages 259–262, 2 illus

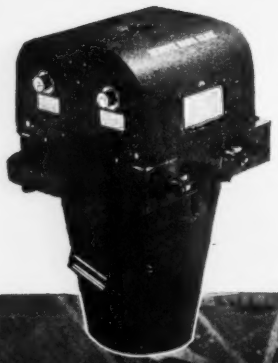
Master Gages Invade Production Line on Mobile Units. H. J. Chamberland. This article demonstrates the advantages of having master inspection gauges set up on mobile units so that they can be moved directly to the production machines and used wherever and whenever needed. It also suggests the basic components required for a mobile inspection laboratory, describing the function and value of each precision instrument. The inspection equipment deemed necessary for the mobile units include: an 81-piece set of precision gauge blocks; an assortment of precision gauge-block instruments to amplify the use and precision of the blocks; a monochromatic light; optical flats; and a comparator. *Aero Digest*, June 1, 1944, pages 84, 85, 125, 126, 6 illus.

Instrument Flying

Let's Make Instrument Flying Easier. Jean H. Hamelet. A pilot appeals for the redesign of blind-flying instruments, as well as their rearrangement and standardized grouping on the instrument-flying panel. He suggests a "cross system" of disposition which is illustrated in the article. In this arrangement all the instruments used to maintain the airplane's heading are on a vertical line and all the instruments for keeping the altitude are on a horizontal line. Air-speed and bank-and-turn indicators are combined in one dial, and wherever possible round dials are eliminated and replaced by vertical or horizontal scales. *Aviation*, June, 1944, pages 138, 139, 3 illus.

Instruments

Sight Unseen. Gerard E. Nistál. Difficulties experienced with the practical application of instrument-landing systems are mentioned. It is noted that after the Pearl Harbor attack the large-scale global operation of military and transport aircraft increased the need for a practical instrument-approach system. The instrument-landing equipment now being used by the



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Army Airways Communication System is described. *Air Tech*, July, 1944, pages 37–40, 74, 9 illus.

Maintenance

Evaluation Toward Elimination of Oil Cans in Skin Panels. J. A. Chamberlin. A study of the factors that determine whether loose skins, or "oil cans," in aluminum-alloy sheet-metal structures require reinforcement during repair or salvage work. Methods of locating "oil cans" and determining their degree of looseness are detailed. The amount of acceptable looseness is defined, and by mathematical analysis it is shown how to evaluate the repeated stresses to which the material will be subjected. *Aero Digest*, June 1, 1944, pages 74, 75, 123, 124, 3 illus.

Overhauling Wright Engines. W. D. Barclay. The procedure followed in the reconditioning of Wright engines at the shops of an air line is outlined. Assembly operations are described and illustrated. *Aviation Service Magazine*, May-June, 1944, pages 12–17, 48, 18 illus.

Hi, Fellah! Joe Chase. Correct procedures for fueling an airplane are advised. In outlining the routine of fueling, the writer offers suggestions on points that require particular attention. *Air Facts*, July, 1944, pages 36–39.

Steps in Servicing Champion Spark Plugs. A group of photographs offer a picture sequence of recommendations from the manufacturers on methods of inspecting, cleaning, and adjusting aircraft spark plugs. Illustrations of the final testing steps prior to installation are included among the photographs. There are also schematic drawings of three types of aviation spark plugs: unshielded; shielded, short thread; and shielded, long thread. *Aviation*, June, 1944, pages 166–171, 21 illus.

Clipper Kits Wing the Atlantic. A lightweight tool kit developed by Pan American Airways for use on its Transatlantic Clippers is described. It is stated that the kit contains 108 different tools and weighs less than 25 lbs. Before the development of this kit the gross weight of personal maintenance and repair equipment for the Clippers was about 75 lbs., exclusive of spare parts. *Air Tech*, July, 1944, page 52, 2 illus.

Tents to Tops in Maintenance. Parker Mitchell. A description is given of the La Guardia Field maintenance base of the American Export Airlines, which, it is noted, is one of the few bases of its kind set up since the Pearl Harbor attack. Information is given about the equipment and some of the methods used at this modern overhaul and maintenance base. *Air Transport*, June, 1944, pages 30–35, 14 illus.

Marketing

Here are Your Markets. Part II—East and West North Central, East and West South Central Regions. John Foster, Jr. Second of three articles reporting the results of a survey to determine what states and regions of the United States present the best customer potential for aircraft distribution.

Part II analyzes the market criteria for the East North Central, East South Central, West North Central, and West South Central regions. It contains tables giving pertinent data about the states in each of the four regions.

These tables show the family population, per cent of national population, per cent of United States buying income, per cent of United States retail sales, number of passenger cars, number of cars per 100 families, number of aircraft registered, and per cent of aircraft registered. They also list the number of pilots registered, number of airports, airports per 1,000 sq. miles, per cent of airports, state market rating, and region market rating. Several of these facts are additionally demonstrated by means of illustrative maps. *Aviation*, June, 1944, pages 114–119, 6 illus.

Materials

Light-Weight Metals in Post-War Industry. Jay M. Sharp. While this is a general article on the future of lightweight metals in industry, sections are devoted to the application of aluminum and magnesium alloys to aircraft. It is stated that a recent estimate indicates that approximately 90 per cent of the current all-time high production of aluminum is being utilized by the aviation industry. It is also noted that today the average military plane contains about 1,000 lbs. of magnesium, and the largest contains nearly a ton. Most of the magnesium is in engine parts and the wheels, although some air frames may include magnesium up to 2 per cent of the total weight of the frame. It is pointed out that, contrary to popular opinion, magnesium is one of the easiest metals to machine. *Machinery*, June, 1944, pages 153–156, 4 illus.; "Magnesium the Metal of Motion," *Aviation and Yachting*, June, 1944, pages 14, 67.

Notes on Magnesium Alloy in Design. R. O. Brittan. Noting that in-

Large aluminum shells being spun by the semimechanical method at an Aluminum Company of America plant. The tool is controlled by two feed screws. One moves the tool back and forth along the work while the other moves the tool in and out, following the contour of the chuck.

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formation regarding the mechanical properties of magnesium alloys is incomplete, the writer proceeds to present considerable data on the subject derived from the experience of the Northrop Aircraft Company. Typical tension and compression stress-strain curves are shown. Among other curves are those showing the improvement in the mechanical properties of J-1 magnesium alloys at subnormal temperatures and the impairment at low temperatures. *Automotive and Aviation Industries*, June 15, 1944, pages 26–29, 8 illus.

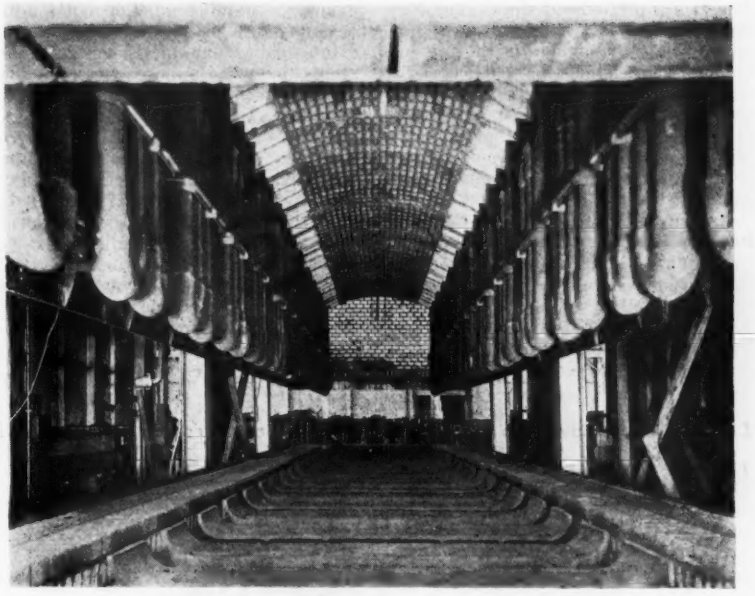
Medicine

The Hyperventilation Syndrome in Flying Personnel. Capt. R. F. Rushmer and Capt. D. D. Bond. Sixteen case histories are reported of the hyperventilation syndrome occurring in members of air crews during flight. A few representative examples of the conditions under which the symptoms occur are presented along with a psychiatric evaluation of the subjects. The conclusions are that: (1) The hyperventilation syndrome appears in flying training, in combat flying, in simulated high-altitude flight, and in association with airsickness and swingsickness. (2) Occasionally the effects of hyperventilation are so severe that they cause temporary incapacitation. (3) Hyperventilation is most commonly a symptom of anxiety or apprehension, and as such it is often an indication of important emotional maladjustment of either long or short duration. (4) With one exception, all the persons who had symptoms of hyperventilation were eliminated from flying for other reasons. (5) Persons in whom this syndrome develops but who are otherwise relatively sound may require no other treatment than a simple explanation of the physiologic mechanism in the production of the symptoms. *War Medicine*, May, 1944, pages 302, 303.

Pilots Are Expendable. S. R. Winters. The subject of neurosis or operational fatigue in Army and Navy pilots is discussed. An instrument termed a "neurometer" for determining the degree of pilot fatigue is described. Case histories of pilots showing chronic exhaustion are given. An eight-point program proposed by the Mayo Clinic to avoid sheer exhaustion in pilots is outlined. *Aircraft Age*, August, 1944, pages 30, 31, 62, 63, 3 illus.

A Migraine-Like Syndrome Complicating Decompression Sickness. George L. Engel, Joseph P. Webb, Eugene B. Ferris, Jr., John Romano, Henry Ryder, and M. A. Blankenhorn. This is a study of the clinical features of certain visual disturbances that are common among subjects experiencing decompression sickness. Presenting data relative to the mechanism of this syndrome, the study emphasizes its striking similarity to clinical migraine. The report is based on observation of 1,361 exposures to simulated altitudes of 30,000 to 38,000 ft. Anoxia was not present in any of the 155 subjects. The symptoms, sometimes accompanied by other focal neurological signs, occurred repeatedly in some persons and not at all in others. A highly significant incidence of migraine headaches was found among the subjects susceptible to the reaction, and evidence is presented that this reaction is mediated through a vascular mechanism that is similar to that described in migraine. *War Medicine*, May, 1944, pages 304–314, 4 illus.

Hay Fever in Pilots. M. Martyn Kafka. The occurrence of hay fever among military pilots is briefly discussed. It is noted that economic and other factors may cause the pilot to withhold information regarding his susceptibility to hay fever from the medical authorities. A pilot may also experience an attack of hay fever as a result of the nature of his flying experience, that is, exposure to new environments. The prophylactic treatments are discussed and preventive measures are suggested. *Contact*, May, 1944, page 26.



An interior view of a Surface Combustion lift-cover, car-bottom furnace, used for the heat-treatment of high-alloy rod and bar stock.

Metallurgy

The Metallurgy of Modern Alloys. R. H. Harrington. The thirteenth and concluding installment of an article on heat-treating processes for modern alloys. The writer concludes a discussion of a possible concept of strain as the pressure variable relative to alloy phase diagrams. The pressure-temperature-composition diagram for cold-rolled tin bronzes is considered. *Steel Processing*, June, 1944, pages 364, 365, 392, 1 illus.

Aging and the Yield Point in Deep Drawing Steel Sheets. Part V. J. R. Low, Jr., and M. Gensamer. This fifth and concluding installment of an article concerning the treatment of deep-drawing steel for strain-aging and yield point consists of an extensive bibliography. *Steel Processing*, June, 1944, pages 372, 373.

Meteorology

Looking Over the Weather. Robert N. Buck. Some advice about the gathering of weather information preparatory to flight. The majority of remarks pertain to the interpretation of weather-sequence reports. *Air Facts*, July, 1944, pages 22–28.

Weathering the War. Bernard Wolfe. A popularized description of modern weather-forecasting methods. The writer tells how long-range forecasts are aiding in the carrying out of military aircraft operations against the enemy. *Mechanix Illustrated*, July, 1944, pages 68–73, 140, 141, 10 illus.

Military Aviation

German Fighter Tactics. David C. Cooke. Some of the tactics used by the German interceptor planes to combat Allied bombers are described. In relating the specific maneuvers, the names given them by the A.A.F. are employed. Those detailed are: the Twin-Engine Tail-Pecker, Swooper, Tail-Gunner's Headache, Double Queue, Triple Threat, Scissors Movement, Sneak Attack-Head-on, Sneak Attack-Tail, Rocketeers, Roller Coaster, Single-Engine Tail-Pecker, and Pepper Spray. *Air Trails*, August, 1944, pages 20, 21, 84, 85, 1 illus.

Naval Aviation

Aeronautical Education in Light of Experience at Naval Aircraft Factory. Lt. L. R. Parkinson. The writer out-

lines the functions of the Naval Aircraft Factory. While he does not recommend any changes in the present aeronautical engineering curricula, he suggests possible future changes that might be beneficial. He states that a little more practical work might possibly be introduced into the curriculum. *The Journal of Engineering Education*, January, 1944, pages 395–397.

America's Prime Weapon—Carrier-Based Aviation. Rear Adm. DeWitt C. Ramsey. Acclaiming the role of the carrier-based plane in the successful waging of the war, the Chief of the Navy Bureau of Aeronautics discusses some of the problems involved in the development of this aircraft type and reviews a number of the outstanding events in the history of its development. He explains some of the design limitations that were imposed by ship-carrying and deck-landing requirements, tells how these handicaps were overcome, and indicates compensating features of carrier air operations. *Aviation*, June, 1944, pages 108–111, 271, 273, 6 illus.

Why Primary Flight Training? Lt. Matthew H. Portz. Certain aspects of training that are distinctive of aviation are discussed in this article about the training of Naval aviators. An outline is given of the Navy's modern primary syllabus. *United States Naval Institute Proceedings*, June, 1944, pages 671–673.

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Paints and Coatings

Zinc Plating of Large Aircraft Structures. Manuel Sanz. The techniques developed for the zinc-plating of complex aircraft structures of large size is outlined. The equipment used for the improved process is described.

The causes of poor plating work are analyzed, and precautions are offered in the form of 15 rules for conducting the operations. Cleaning and passivating practices are also discussed, and suggestions are given for changing tanks from cadmium plating to zinc plating. *The Iron Age*, June 15, 1944, pages 64–70, 13 illus.

Personalities

Major General Lewis Brereton, Air Commander. Jack Swoke. The flying career of the Ninth Air Force's Commander is traced from his exploits in the first World War through his record to date in the second conflict. Some brief notes on General Brereton's characteristics and qualities as a leader supplement the biographical data. *Air Facts*, July, 1944, pages 15–20, 1 illus.

Lawrence D. Bell. Esther H. Forbes. Some biographical notes on the President of Bell Aircraft Company. His affiliation with aviation is traced from his adolescence, through the years he worked for The Glenn L. Martin Company, to the formation of his own company and its progress since 1935. The article tells something of the principles upon which the design of Bell Aircraft's Airacobra is based and indicates some of Mr. Bell's future plans for keeping his plants in production. *U. S. Air Services*, June, 1944, pages 28, 30, 42, 1 illus.

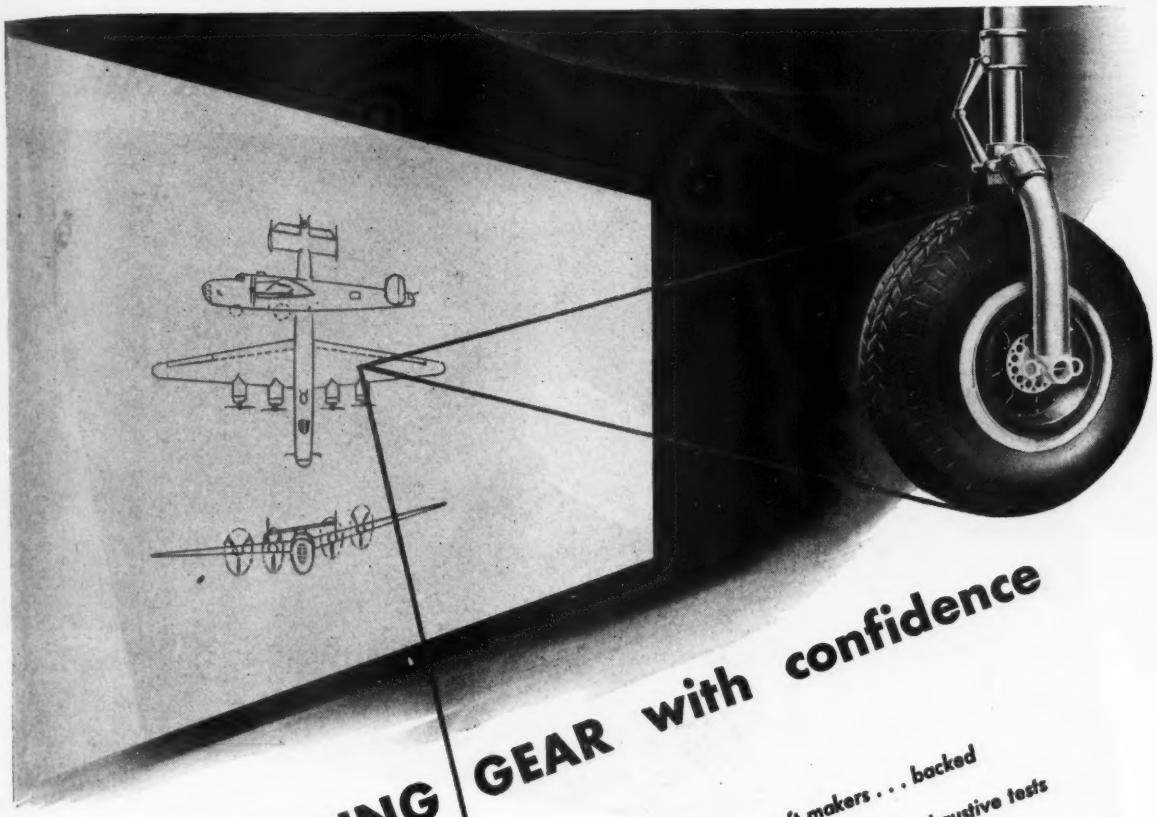
Personnel

Your Draft Status. Charles Wilson. A discussion of how the latest Selective Service regulations will affect key personnel of commercial air lines and aircraft manufacturing concerns. Figures are quoted to show numbers and percentages of aviation employees who come under draft regulations pertaining to age classifications of Under 22, 22–26, and 26–30.

The article is supplemented by two tables: the first shows the number of key air-line personnel who are under 26 and the jobs they hold, and the second gives a breakdown of draft-age air-line male personnel by jobs and companies.

Flight personnel and maintenance personnel are listed separately in both of these tables. *Flying*, July, 1944, pages 47, 48, 1 illus.

Air Wacs. Capt. Marion Lichty. The diversity of jobs that are being performed by WAC members in the Air Forces is noted. Some information is included about the methods by which Air Wacs are selected for their different duties. *Air News*, July, 1944, pages 35, 37, 8 illus.



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Plexiglas "bubble" canopies for P-47 Thunderbolts waiting to be trimmed and finished at a plant of the Rohm and Haas Company.

Photography

Aero-Triangulation. Theodore H. Drummond. A new idea for "aero-triangulation" is described. The plan involves the use of a tow plane and a glider, both of which are equipped with aerial cameras on gyroscopically controlled mounts. A description is given of the apparatus and methods suggested. *Photogrammetric Engineering*, April-May-June, 1944, pages 62–64, 3 illus.

Aerial Photography as a Map Substitute. Louis A. Woodward. The development of aerial photography and its application to the making of maps is reviewed. The use of aerial photography by the Soil Conservation Service of the Department of Agriculture is discussed. The writer describes various problems encountered and how they were solved. One of these was the making of land-use maps to aid in the prevention of soil erosion. Photographic techniques and procedures are discussed in considerable detail. *Photogrammetric Engineering*, April-May-June, 1944, pages 68–81, 6 illus.

Plants

A Pioneer Engine Test Building. Constructional features of an airplane-engine test building built at a Midwest Army air base are described. Test cells 95 ft. long and of 20-ft. throat diameter were built of concrete, heavily reinforced. The construction of the interior forms presented a difficult problem, and the solution is described. It is explained that to reduce vibration the foundations were carried to rock, and footings for the engine mounts were insulated from the rest of the structure. To control the noise generated by test engines, sound-absorbing baffles and insulation were used. *Engineering News-Record*, June 15, 1944, pages 89–91, 8 illus.

Plastics and Plywood

Effect of Environmental Conditions on Mechanical Properties of Organic Plastics. Part I. T. S. Carswell and H. K. Nason. In the first section of a two-part study it is noted that most organic plastics appear to be especially sensitive to their physical and chemical environment. Temperature variations within the normal terrestrial range of −80 to +160°F. can cause changes in mechanical properties which would take place in metals only over a much broader temperature range. Moisture has a profound effect, and other conditions include light, oxidation, time, and the combined actions known as weathering. Some of the more important mechanical properties that must be evaluated for each plastic material are: (1) tensile, flexural, compressive, and shear strengths; (2) stiffness and rigidity; (3) ductility; (4) impact resistance; (5) creep and stress endurance; (6) fatigue characteristics; (7) dimension stability; (8) physical durability. Stress and strain and the effects of temperature are discussed at length in the first part of the article, with the aid of curves resulting from general tests for stress and strain, elongation, deflection, deformation, impact, and other properties upon various kinds of organic plastics at different temperatures within the range of −80 to +200°C. A bibliography of 157 references accompanies the first part of the article. *Modern Plastics*, June, 1944, pages 121–126, 158, 160, 21 illus.

Meet Melamine. Charles J. Romieux. The rapid growth in the use of resins produced from melamine is shown in this article. Various applications of the resins, including those to the ignition systems of aircraft engines, are described. *Scientific American*, July, 1944, pages 25–28, 4 illus.

Load Characteristics of Cellulose Acetate Plastic. Part I. William N. Findley. The first of a series of articles containing an extensive analysis of the load-resisting properties of cellulose acetate plastics begins with a statement of the purpose of the study. The tests were undertaken to obtain more nearly complete information regarding the mechanical properties of the material and to determine the effect of certain variable conditions involved in the techniques of service and testing. The mechanical tests discussed include static strength tests in tension and compression and fatigue and creep tests. Some of the variables whose effects were studied include the effect of speed testing in both static tests and fatigue tests, of moisture content, of range, of stress in fatigue, and of stress on the creep in tension. The materials and specimens, furnished by Monsanto Chemical Company, are described in detail, as well as the testing apparatus and the methods employed. The results are summarized and compared. Further observations are made with reference to the effect of the testing speed on the tensile properties, aging, and the effect of transverse holes on the tension tests. *Aviation*, June, 1944, pages 146–149, 263, 265, 269, 9 illus.

Postwar Aviation

The Future of Civil Aviation. Part I. A. H. R. Fedden. The first of two articles reporting the Cantor Lecture of The Royal Society of Arts, given by the writer on April 24, in which he expressed his views regarding the trends that British postwar civil aviation will follow. This first article summarizes the history of prewar civil aviation both in Britain and other countries; it outlines a program for meeting the requirements of future international aviation; and it suggests a six-point policy for Britain, insuring immediate action on the question of British and Dominion civil aviation. It then goes on to discuss routes, organization, productive capacity, airdromes and airport management, and the progress that will be made in the development of aircraft design, types of British air liners, and fuels and oils for future civil aviation. Throughout the discussion, Britain's position and her opportunities for developing future air commerce are compared with those of

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other countries. *The Aeroplane*, May 5, 1944, pages 495–499, 7 illus.

International Air Policy Terms Discussed. E. J. Foley. In this article the writer discusses "Freedom of the Air," air sovereignty, and the relaxation of air sovereignty by the nations of the world in order to provide operational accessibility. He considers "Freedom of the Air" to be an impracticable concept and states that it would be better if the term were dispensed with entirely. *American Aviation*, June 15, 1944, pages 72, 74, 1 illus.

Air Castles or Realism? W. A. Patterson. In this article the President of United Air Lines reiterates his opinion that one or more chosen instruments should handle international air transport for the United States. Equipment needs of the United Air Lines are forecast in sections discussing the types and quantities of aircraft required, expenditures, and revenues. Other phases of the aviation industry's future are included. *Air Transport*, June, 1944, pages 20–25, 5 illus.

Let's Get Down to Earth About Aviation's Postwar Prospects. W. D. Burchall. A discussion of the factors involved in a determination of how big Canada's aircraft industry will be after the war. The problem is considered from its various angles—main-line air service, feeder lines, military requirements, international air service, and private planes. Summed up, the opinions of the writer are: (1) The still unresolved military situation and the lack of a defined tariff policy preclude any accurate estimate as to the postwar size of Canada's aircraft industry. (2) All indications point to a steady increase in domestic and international flying, with no lack of planes or personnel to fly them. (3) Where speed is not essential, cost will rule and the goods will be sent by surface transport. (4) Wartime repair shops and overhaul facilities are on such a large scale that it is certain they will have to be curtailed. (5) Air transport has no monopoly of virtues, and the ultimate size of the aircraft industry will depend upon the ability of its members to eliminate certain of its limitations. *Canadian Aviation*, June, 1944, pages 75, 88, 90, 92, 1 illus.

The Economic Future of Aviation Technology. Part I. Frederic Flader. This is the introductory article in a series appraising the value of various aircraft types in the coming peacetime economy. The discussion emphasizes the point that future progress of commercial aviation depends upon the ability of manufacturers to produce airplanes that will operate at lower cost. In Part I the writer endeavors to prove that air-line companies must be enabled to transport air cargo at substantially reduced charges if there is to be any increased volume of traffic. Claiming that cost rather than time is the prime factor in shipping air cargo, he demonstrates that the increase in air express during the past few years has not kept pace with the rise in air-passenger and air-mail transportation. He also compares the higher costs of shipping by air with other means of freighting. In subsequent articles he examines the technical possibilities for airplanes' meeting the requirement for lower shipping costs. *Aviation*, June, 1944, pages 120, 121, 277, 279, 3 illus.

You and the Air Future. D. C. Alexander. Based upon the questions asked in a survey being conducted by American Airlines, this is an indication of some of the passenger conveniences that will be offered by the air lines after the war. Among the things discussed are private compartments; more accessible accommodations for luggage; better kitchen facilities; separate smoking sections; conveniences such as telephones, radios, libraries, etc.; reserved seats; transportation from air terminals; and accessibility of air terminals. *Air News*, July, 1944, pages 24, 25, 27 illus.

A Preface to Postwar Planning. Part V. Airports and Landing Fields. George E. Haddaway. Part V in this series of articles on postwar aviation planning takes up the question of airports and landing fields. In it the writer gives his views on how many airports will be needed in the United States after the war, what kinds, and where they should be located. Directing attention to the importance of low-cost facilities, he also emphasizes the necessity for coordinating Federal, State, and local airport programs. The economic value of a national airport program is also indicated. *Southern Flight*, June, 1944, pages 40, 42, 44, 1 illus.

Air Transport Charter? Z. Ciolkosz. Pleading for the right of smaller European nations to an equitable participation in postwar air transport, the writer suggests factors upon which to base the extent of their inclusion in an international air-line system. The qualifying factors are: (1) contribution of a particular country to the common war effort and its faithfulness to the Allied cause; (2) previous contributions to the development of air communications, considered in the light of the country's potentialities and its prewar air-transport requirements; (3) participation in world economy and the need to link the mother country with overseas possessions or bigger settlements abroad; (4) natural conditions favorable to the development of communications, such as the geographical situation of a country, its topography, atmospheric conditions, etc. *Flight*, May 25, 1944, pages 562–564, 1 illus.

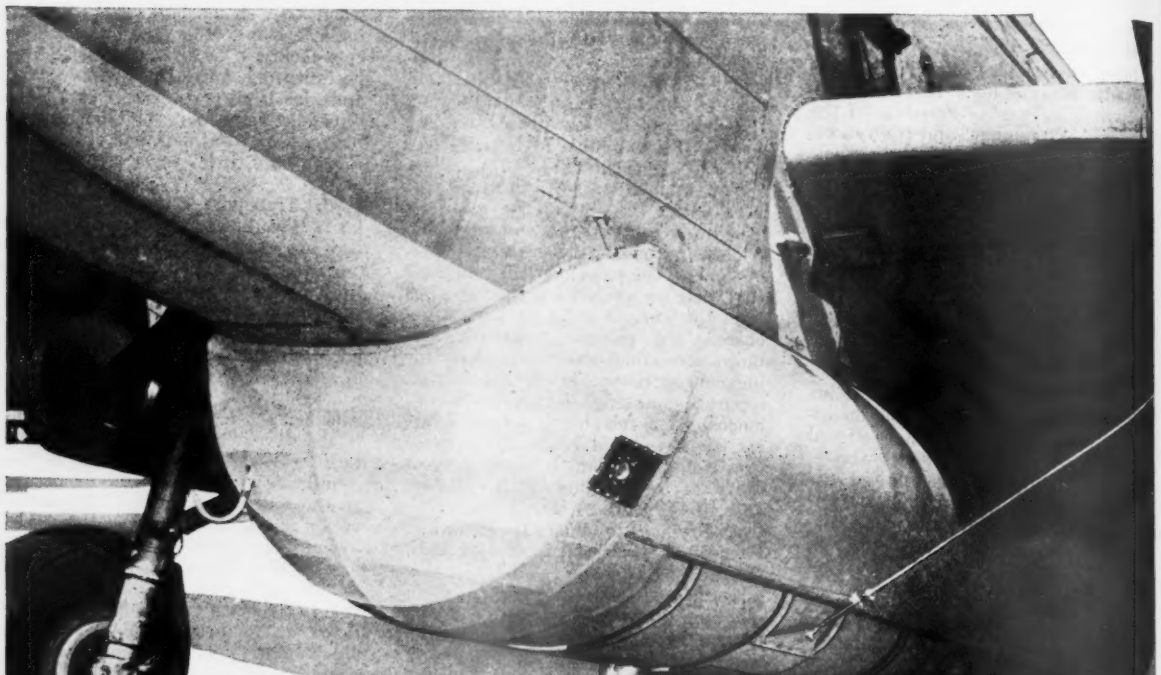
Production

Designing Castings and Forgings. Part I—Sand and Permanent Mold Castings. James E. Thompson. The first article in a series on the design of castings and forgings deals with sand and permanent-mold castings. It discusses general design considerations and practices in producing castings by these two methods. Basic factors outlined for sand casting designs are: (1) All surfaces must be drafted away from the parting line. (2) Only one parting line should be required, and this should be straight. (3) Bosses should not require loose pieces on the pattern or setting cores. (4) Adequate core support must be provided. (5) Wall thicknesses and areas must be within practical limits. (6) Fillet and corner radii must be practical. (7) Lightening holes should be round or oval. (8) Sharp edges should be avoided. (9) All surfaces requiring machining must be indicated on the drawing. (10) Ample "edge-distance" must be provided for drilled holes. (11) Extreme section variations must be avoided. (12) Casting inserts should be used where practicable. (13) Structural castings should not be subjected to large, concentrated alternating tension loads. (14) Control-system castings must be accessible for visual inspection. Attention is called particularly to considerations of wall thickness and machining allowances. Although the two methods are stated to be similar, variances in technique which distinguish permanent-mold casting from sand casting are indicated. *Western Flying*, June, 1944, pages 58, 60, 62, 64, 10 illus.

Burgess Norton Now Produces Aviation Piston Pins and Tank Threads. Joseph Geschelin. A description of the production methods used by a company that has long specialized in the manufacture of piston pins for automotive engines and has now extended its activities to the production of aircraft-engine piston pins and tank treads to meet war demands. Production techniques are outlined, and manufacturing equipment is described and illustrated. *Automotive and Aviation Industries*, June 1, 1944, pages 18–21, 152, 154, 10 illus.

Hawker Typhoon. Part III: The Tail Unit; Fuselage Decking; Radiator Fairing; Machined Parts. Wilfred E. Goff. The conclusion of a three-part article about the production processes employed by the Gloster Aircraft Company, Ltd., in the manufacture of the Hawker Typhoon. Part III contains a description of the assembly processes used in building the various surfaces of the tail unit. It also includes a summary of the assembly operations connected with the radiator fairing, fuselage decking, and machined parts of the British fighter plane. The sequence of subject headings is as follows: tail-plane assembly, main fixture, rudder, elevators, fuselage decking, and undercarriage-pivot casting. *Aircraft Production*, June, 1944, pages 263–272, 30 illus.

New Developments in Forging Ferrous and Non-Ferrous Metals. R. W. Thompson. As a guide to those who are undertaking the production of fer-



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rous and nonferrous metal forgings for aircraft, the writer describes the different classes of forgings and the ways of producing them. He explains the methods used for producing closed-die forgings and flat-die forgings. Subjects discussed include the fabrication of propeller blades, aluminum-alloy and steel crankcases for radial engines, pistons, impeller-gear shafts, exhaust flanges, and landing-gear assemblies. The method of forging magnesium-alloy parts also is described. *The Iron Age*, June 8, 1944, pages 54–57, 2 illus.

"Mariner" Production Presents Novel Features. Nils H. Lou. Special manufacturing techniques used by The Glenn L. Martin Company in the production of the PBM-3 Mariner flying boats are described in detail. Fabrication processes are reported to follow a modified subassembly scheme, with the aircraft divided into three major sections for production purposes —the hull, the center wing, and the outer wing. Major subassemblies consist of the forward crown and pilot's cabin, two aft crown sections, tail section, pilot's floor, navigator's floor, and tank assembly. In addition to information about the manufacturing procedures, the article includes data on the jigs and fixtures employed. *Aero Digest*, June 1, 1944, pages 86–88, 90, 91, 117, 118, 17 illus.

Stepped Extrusions Kirby F. Thornton. The development of stepped extrusions made from aluminum and their use as wing-spar caps for military aircraft is traced. It is noted that stepped extrusions in some cases provide economy of material and machining time, especially when the attachment fitting is to be integral with the spar cap. The method has been used for making spar caps so large that it would not have been possible to fabricate, on existing equipment, an extrusion having a uniform full cross section long enough for the work. The first actual use of stepped extrusions on an experimental airplane is described, as well as the tests made by the Aluminum Company of America to establish the mechanical characteristics of parts made by this method.

Methods for the production of stepped extrusions and inspection processes and means for assuring the accuracy of the finished parts are discussed. It is stated that the use of stepped extrusions is predicated almost entirely upon economic factors, each case having to be judged on the basis of the suitability of the process for the service involved. Weight, cost, and other factors would determine whether stepped extrusions or some other type of construction would be best for the purpose. The discussion is limited to extrusions having only one step, it being stated that theoretically it could be feasible to make them with as many steps as might be desired but economic factors again enter into the matter. The advantages must be weighed against the costs and other complications. Up to the present, numerous jobs have been found to justify the single-step extrusion, but none has yet appeared which would warrant a second step. *Mechanical Engineering*, July, 1944, pages 443–446, 10 illus.

Close-up of trimming operation in a Bliss press, showing the die and punch and providing a good view of the size and formation of the forging.

Continuous Casting. T. W. Lippert. A description is given of various machines in which molten metal is poured into one end, and continuous lengths of billets, sheet, or strip emerge from the other end. It is noted that practically all aluminum, magnesium, and copper alloys are now cast in this manner. Experiments being conducted to cast steel in this way are said to show great promise. *Scientific American*, July, 1944, pages 19–21, 2 illus.

Rolled Threads for Aircraft Engine Parts. Franklin M. Reck. As typified by Chevrolet practices in using rolled threads for studs, screws, and bolts of Pratt & Whitney aircraft engines, this article indicates the advantages of rolling engine threads instead of die-cutting them. Rolling is claimed to result in a smoother thread with a greater degree of accuracy, saving of production time, and a minimum of variations in size and number of lead threads. Chevrolet procedures of thread-rolling are described. *Aero Digest*, June 1, 1944, pages 114, 116, 5 illus.

Straight-Line Production Improves Quality. C. E. Bleicher. Progressive production-line methods utilized by the DeSoto Division of the Chrysler Corporation for the manufacture of air frames are outlined. Adopted from automotive methods, this system has as its basis a straight-line material flow. However, it is not entirely confined to conveyerized assembly lines, and stationary assembly fixtures are used wherever conditions warrant. The material is scheduled into the plant according to a "four-wall" inventory, and parts are inspected at the plants where they are fabricated rather than at the assembly plants. In addition to information about working procedures, the article includes details on various assembly fixtures that are used. *Wings*, July, 1944, pages 1093–1097, 12 illus.

Methods for Forming Sheet Aluminum. Part II—Spinning of Aluminum. The second of a series of articles about the techniques of sheet-metal forming. Part II describes how circular aircraft parts are formed without dies or drop presses through the spinning of aluminum. In addition to tracing a simple spinning operation from start to finish, it discusses the best grades of metal to use, methods of annealing, proper tools, the way to lubricate, and correct lathe speeds. Two supplementary tables list the speeds for spinning aluminum discs and those for spinning aluminum shells. *Aviation*, June, 1944, pages 154, 159, 253, 255–257, 6 illus.

Anderson Aluminum Forge Plant. Joseph Geschelin. A description of Chevrolet's Anderson, Ind., aluminum forge unit, which is turning out aircraft forgings ranging from minute engine parts to 8-ft. propeller blades. It is noted that the property covers 21 acres and was formerly used as a wire mill. The conversion of the plant is described. A distinguishing feature of the new unit is the adoption of some of the largest equipment of its kind, including 2,000-ton H-P-M hydraulic presses, 4,000-ton Clearing presses, 8-in. Ajax upsetters, and a large battery of Surface Combustion Company gas-fired heating and heat-treating furnaces, as well as a large homogenizing furnace. Illustrations show some of the equipment and drop-forging operations. *Automotive and Aviation Industries.*

June 15, 1944, pages 22–25, 102, 9 illus.

Safe Practices in Working Magnesium. Arthur C. Stern and Charles B. Ford. A review of safe-practice recommendations for the prevention and control of fire and explosion hazards in plants fabricating magnesium alloy. Also discussed are the occupational health hazards that may exist in magnesium foundries because of atmospheric contaminants, among which are the fluorides, sulphur dioxide, carbon tetrachloride, and chromium compounds. *The Iron Age*, June 22, 1944, pages 64–70, 3 illus.

Stringer Production. An account of the multitooling methods developed by the Metropolitan-Vickers Electrical Company, Ltd., for the production of stringers for the fuselage of the Avro Lancaster bomber. The procedures are described according to the following sequence of operations: (1) cut stringers to length; (2) mill (or crop) cutaways; (3) mill ball or curl stringers where necessary; (4) slot; (5) predrill; (6) dress; (7) assemble bridge pieces and end brackets. Photographs and schematic drawings help to interpret the stringer-production processes. *Aircraft Production*, June, 1944, pages 295–298, 13 illus.

"Cribbage Boards" Boost Liberator Production. Consolidated Vultee's system of "control boards" is described. Set up at each station on the assembly lines, the control board enables factory supervisors to have a detailed picture of the station's production status. Pegs are used to represent operators and colors are used to indicate station, shortage, shift, and other conditions. *Wings*, July, 1944, pages 1100–1102, 7 illus.

The irregularity of receipt of publications from abroad necessitates the review of articles in issues several months late. This is done to provide readers with information regarding foreign technical progress as soon as the issues are available in the United States.

Propellers

Propeller Design Requirements. H. M. McCoy. Functional requirements which have formed the basis for propeller development by the U.S. Army Air Forces in recent years are separately discussed in considerable detail.

The importance of feathering and reverse pitch with a maximum rate of pitch change of 45° per sec. is emphasized. Experiments show that reverse-pitch propellers are at least as effective in ground braking as the best wheel brakes. They are more effective than any known flap-type dive brakes in retarding aircraft in flight.

Air-line experience indicates an emergency feathering of the propeller to stop a damaged engine occurs every 3,000 engine-hours on the average. The full-feathering propeller is without doubt the most valuable single contribution in the past decade to safety in flight of multi-engined aircraft.

Tracings are included of oscillograph records of propeller governing response to propeller and engine control changes for different types of governors and rates of pitch change. It is shown how improved governing to prevent overspeeding has permitted increasing engine ratings by 10 per cent during the past few years. Further developments in anticipatory governing promise to give an additional 10 per cent improvement.

It is pointed out that refinements in hollow steel blade design permit saving as much as 25 per cent in the weight of a given propeller. The effect of weight-savings of this magnitude on transports and military aircraft operation is illustrated by factual examples.

A survey is made of current experiments on propeller ice elimination, and attention is focused on the promise of pastes and thermal means to solve this difficult problem.

Numerous other items which must be included in a propeller design to make it successful are briefly discussed. *Journal of the Aeronautical Sciences*, July, 1944, pages 261–271, 10 illus.

Radio

The Klystron. Capt. Eugene E. Skinner. The Klystron tube is defined not as a specific tube but as a type of tube that applies the principle of modulating the velocity of the electrons as they flow through it and which has at least a portion, and possibly all, of the oscillating circuit components included as integral parts of the tube. A detailed description of the tube and the principles of its operation are given. Various operations for which this type of tube is suitable are discussed, and information is given about its applications and the different variations in which it is available. One of the most important variations is known as the Reflex Klystron, a description of which is included. *Air Tech*, July, 1944, pages 54, 56, 60, 3 illus.

Selecting Radio for Post-War Airplanes. Major William P. Lear. The first of a series of articles in which advice is offered to the civilian plane owner on how to select his postwar aircraft radio. Part I defines the purpose and necessity for the radio-range receiver, the communications transmitter, the radio direction finder, and the auxiliary dry-cell powered beacon receiver.

Stressing the importance of correct installation, it also discusses the airplane's speed and available space as considerations in selecting a radio for a specific plane. *Air Pilot*

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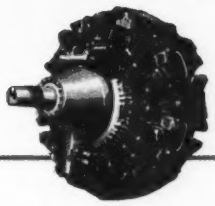

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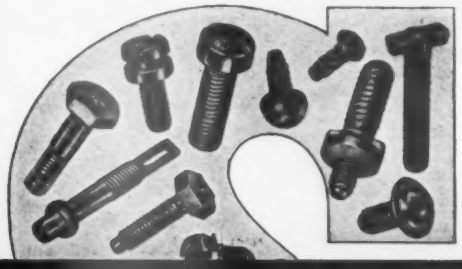

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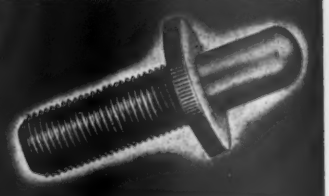

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and Technician, June, 1944, pages 4–6, 8 illus.

Radio Testing Station. A brief description is given of the operational radio-testing station located on a hill in the metropolitan area of Los Angeles and operated by the Lockheed Aircraft Corporation. Although the primary purpose of the station is to provide testing facilities for the radio equipment installed in all Lockheed airplanes, it is stated that there are many other possible uses for the station in a wide variety of radio work.

A brief description is included of the methods followed in testing aircraft radio apparatus through facilities provided by the station. *Air Tech*, July, 1944, page 58, 2 illus.

Reaction Propulsion

Misconceptions in Jet Propulsion. G. W. Walton. To provide a clearer understanding of the jet-propulsion principle, the writer explains some common misconceptions. Four jet-propulsion systems, two of which are stated to be practical, are illustrated and discussed. Factors discussed include propulsion efficiency, the heat-engine aspect, intermittent flow and intermittent heating, backward expansion effects, continuous flow with continuous heating, precompression and velocity, and energy balance. *Aeronautics*, June, 1944, pages 46–50, 5 illus.

Rotating Wing Aircraft

British Helicopters. C. M. Poulsen. A series of three British rotating wing aircraft designs is described and the features of each are analyzed. The aircraft are the Weir W. 3, W. 5, and W. 6. The first is a "jump-start" autogiro and the last two are helicopters. As reported, the first Weir helicopter, the W. 5, was of wooden construction. The outriggers that carried the side-by-side rotors were also of wood and were plain boxes without fairings, while the engine was a four-cylinder air-cooled model developing 50 hp. at 2,500 r.p.m. and cooled by a special blower. Transmission was accomplished by a single-plate clutch to a primary gearbox and then by universal-jointed shafts to the rotor hubs. The two-bladed rotors were geared down to run at 410 r.p.m., and the length of the wooden blades was 7 ft. 6 in. Complete with pilot, fuel, and oil, the loaded weight was 840 lbs., so that the power loading was about 17 lbs. per hp.

In the W. 6 the same rotor arrangement was employed, but the aircraft had a Series II Gipsy VI engine of 200 hp. at 2,400 r.p.m. A special blower was designed for cooling it. The W. 6 was of metal construction so far as the air frame was concerned, but the rotor blades were of wood. Light-alloy tubes were used in the fuselage, except in the rear bays which were of steel tube. The transmission was by a fluid coupling

to a primary gearbox and by universal-jointed shafts to the rotor hubs. The three-bladed rotors ran at 275 r.p.m., and the wooden blades had a length of 12 ft. 6 in. The loaded weight, with pilot, passenger, fuel, and oil, was 2,400 lbs. *Flight*, May 11, 1944, pages 498–502, 16 illus.

New 'Copter Design Tested at Detroit. A brief report about a new helicopter that was designed and is being built by Arthur C. Schouw, of Birmingham, Mich. It is stated that this all-metal aircraft will have counter-rotating rotors with a new type of blade and a pusher propeller. The first model will have a four-cylinder 105-hp. engine. It is expected to cruise at 95 m.p.h. and to be able to reach an altitude of 10,000 ft. *Aviation News*, June 5, 1944, page 15.

Limitations of the Helicopter. Grover Loening. In reviewing reasons why he believes the helicopter will not come into general usage by private fliers immediately after the war, the writer predicts that its professional applications will be extensive. The limitations of present helicopter designs which he points out include: the great amount of skill necessary for piloting them; inherent speed and size limitations; poor performance at increasingly high altitudes; vibration; and cost of construction. Applications for which the helicopter is stated to be immediately suitable include its use for air lines, exploration work, carrying personnel and goods to inaccessible places, lifesaving, ice patrol, Coast Guard, law enforcement, etc. *Flying*, July, 1944, pages 24, 25, 176, 3 illus.

Military Progress in Helicopters Presages Early Commercial Models. William G. Key. Advances in helicopter designs are discussed, and the effect of the rapid progress in military models on the development of future commercial models is considered. It is stated that designs are already beginning to be stabilized and that attention can be given to load and space factors. Reference is made to three military models to be produced by the Sikorsky Division of the United Aircraft Corporation. Two of these are the XR-5 and the XR-6. The XR-6 is an improved helicopter based on the R4-B, which is the production model of the YR-4.

To illustrate the progress that is being made in helicopter design, the features of the YR-4 and XR-5 are compared. The former has a vertically mounted Warner engine of 180 rated hp., gross weight of 2,530 lbs., and net weight of 2,011 lbs. The XR-5 has a 450-hp., horizontally mounted Pratt & Whitney Wasp Jr. engine. Empty weight is 3,725 lbs. and gross weight is 4,800 lbs. *Aviation News*, June 19, 1944, pages 12, 13.

Stress Analysis

Plastic Bending. William R. Osgood. The relation between bending moment and curvature in a beam is worked out on the assumption that the stress-strain relations are the same in bending as in pure tension and pure compression. The general equations are applied to an I-section with thin flanges, and a numerical case is worked out for the rectangular section, the idealized I-section (negligible web), and a T-section for three widely different stress-strain diagrams. Deflections of beams stressed in the plastic range are considered.

It is hoped to present later the solution for a beam the two sides of which are parabolas with the vertices out—that is, a beam with material concentrated toward the middle. *Journal of the Aeronautical Sciences*, July, 1944, pages 213–226, 8 illus.

Effects of Material Distribution on Strength of Panels. Adam Zahorski. This article discusses the effect of material distribution between skin and longitudinal stiffeners on the strength of flat panels subjected to the action of compressive forces only. The idealized panel forms—such as square, triangular, or circular corrugations; various shapes of hat sections, double skin constructions; and variation in skin thicknesses—are analyzed. A structural parameter P/L, which determines the optimum design stress for a given panel form, is also introduced. *Journal of the Aeronautical Sciences*, July, 1944, pages 247–253, 12 illus.

A Theorem on the Shearing Stress in Beams with Applications to Multicellular Sections. J. N. Goodier. The methods in use for the calculation of the flexural shearing stress in wing beams of multicellular section are rigorously examined by means of the Saint-Venant theory of flexure and torsion. It is shown that the line integral of the shearing stress around a cell does not, in general, vanish as has been supposed. Its value is found in a simple form. The effect on the magnitude of the shearing stress is calculated for several examples and found small for certain one-, two-, and three-cell sections. Solutions of the flexural shear stress problem are given for rectangular cell sections of one, two, three, and any number of equal cells, with flange areas. *Journal of the*

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Thus, the added planing area provided by the bottoms of the tanks, compensates for their increased load to such an extent that take-off characteristics remain about the same as they would without the fuel-filled sponsons. Translated into terms of operating efficiency, this means added range or payload with only a 2% reduction in top speed. Even this reduction in speed is not necessary throughout the entire flight, since the sponson tanks may be jettisoned when empty.

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Aeronautical Sciences, July, 1944, pages 272–280, 10 illus.

Measurement of Dynamic Stress and Strain in Tensile Test Specimens. R. O. Fehr, E. R. Parker, and D. J. DeMicheal. This paper reports tests in which measurements of stress and strain were made on test samples of cold-rolled steel (SAE-X-1112) and of Dural (17-ST), while specimens made from these materials were being broken by a force applied at a high rate of speed in a commercial high-velocity impact-testing machine. The object of the paper is to present some results of these tests, to explain the technique and the analysis used, and to demonstrate the adequacy of this technique and analysis.

The dynamic tensile strength, the dynamic yield strength, the dynamic breakage energy, and the dynamic elongation of the tested materials were found to be higher than the corresponding values obtained in the static tensile test. The values for these four material characteristics increased with increasing striking velocity. The increase of the strength value above the static-strength value was in most cases less than 50 per cent up to a striking velocity of 100 ft. per sec., which was the highest test velocity. *Journal of Applied Mechanics*, June, 1944, pages A-65–A-71, 20 illus.

Airscrew Stress Coefficients. T. H. Day. It is explained that in the design of hypothetical propellers and general investigations on performance the calculations are often based on values of torque and thrust coefficients from a family of propellers or by the use of Lock's method assuming an elliptical grading. It is sometimes desirable to ascertain whether the corresponding stresses in the blades are satisfactory. This is a laborious process as far as the aerodynamic bending stresses are concerned, since before calculating the bending moments at each section it is necessary to calculate the aerodynamic forces.

The writer derives curves by means of which the values of stress coefficients corresponding to the flight condition and blade setting can be read for each section of the blade. Two alternative methods of calculating the aerodynamic bending stresses are given, as well as computations for determining the tensile stress caused by the centrifugal force of the blade.

The values of the stress coefficients given are based on the elemental nondimensional torque and thrust coefficients obtained by analysis of the family of propellers by means of the vortex theory, with no assumptions other than those normally assumed in the standard method of stressing propeller blades. *Aircraft Engineering*, May, 1944, pages 128–130, 11 illus.

Control Surface Flutter Considerations. R. T. Shaftel. Conditions that must be met in the design of a control surface in order to prevent flutter are discussed with particular reference to the responsibility of the weight engineer

Two of these conditions are defined as the location of the center of gravity and the moment of inertia of the surface. An experimental method for determining the moment of inertia is given, together with the necessary mathematical calculations. It is stated that the derivation of the equation is incomplete but adequate for the purpose. The procedure is outlined in four steps.

In the summary it is noted that the accuracy of the test depends upon the determined values of the frequencies of the system oscillating about an axis under the influence of a spring or set of springs. Extreme accuracy must be maintained in calibrating the springs. *Aero Digest*, June 1, 1944, pages 104, 220, 4 illus.

Measurement of the Damping of Engineering Materials During Flexural Vibration at Elevated Temperatures. Carl Schabtach and R. O. Fehr. The method and equipment developed and used by the writers for measuring the damping of materials are described. A tuning-fork specimen is set into vibration. The damping is expressed in terms of the logarithmic decrement of the decaying vibration, which is measured and recorded by means of a magnetic oscillograph, amplifiers, and a resistance-type electric strain gauge cemented to the specimen. The results include (1) the damping of a number of materials during flexural vibration at approximately 1,000 cycles per sec., at maximum bending stresses up to 40,000 lbs. per sq.in., and at temperatures up to 1,400°F.; (2) the variation in modulus of elasticity with temperature, as determined from the specimen vibration frequencies.

Among the conclusions it is stated that data obtained from tuning-fork specimens are directly applicable to parts subjected to vibratory bending, whereas those obtained from the commonly used low-frequency torsional machine are particularly applicable to parts such as shafting which may vibrate in torsion. Either test, perhaps, is suitable for classifying materials as to damping under any condition of stress, but this still has to be established by carefully conducted comparative tests. *Journal of Applied Mechanics*, June, 1944, pages A-86–A-92, 4 illus.

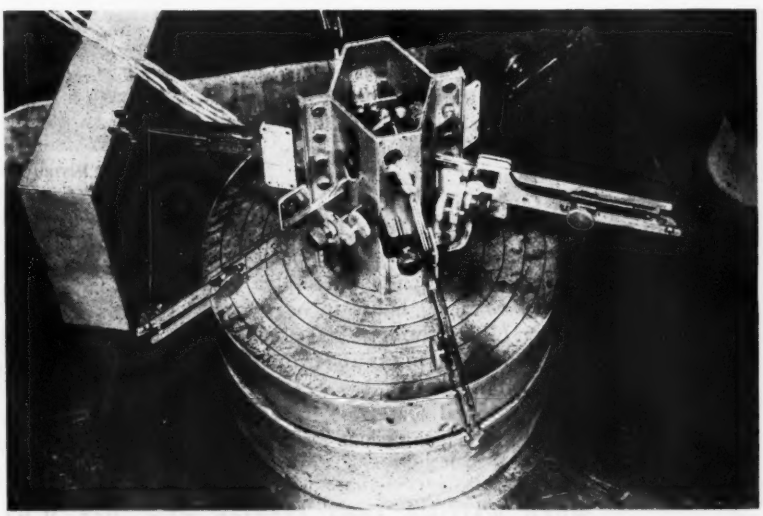
Data on Springback of Metals. Robert E. Oestreich. A method of mathematical analysis is presented for the predetermination of springback in metals that are deformed past the elastic range. The calculations are stated to be valid only in the bending of metals and not where stretching, shrinking, or drawing of the metal are involved.

Since the method is based upon the assumption that the original cross sections remain plane and biaxial stresses are not considered, another restriction is that the bend radius must be relatively large with respect to the section depth. The prescribed formulas are applicable only to simple, circular curves where these factors are known: (1) the stress-strain characteristics of the metal, (2) the complete cross-sectional dimensions of the specimen, and (3) the final bend radius desired. Data obtained through this system of analysis are recommended as being accurate for die-making purposes. *Aero Digest*, June 15, 1944, pages 77–81, 138, 7 illus.

Testing

Improved Methods for Determining the Compression Properties of Sheet Metal. K. R. Jackman. The development of a test procedure and test equipment for quickly and accurately determining the compressive properties of thin sheet-metal coupons is described by Consolidated Vultee's chief test engineer. *Automotive and Aviation Industries*, June 1, 1944, pages 36–38, 82, 6 illus.

Swinging Ship on a Liberator Bomber. An article which describes



Extensometer placement on compression specimen of conventional 5-in long double hat.

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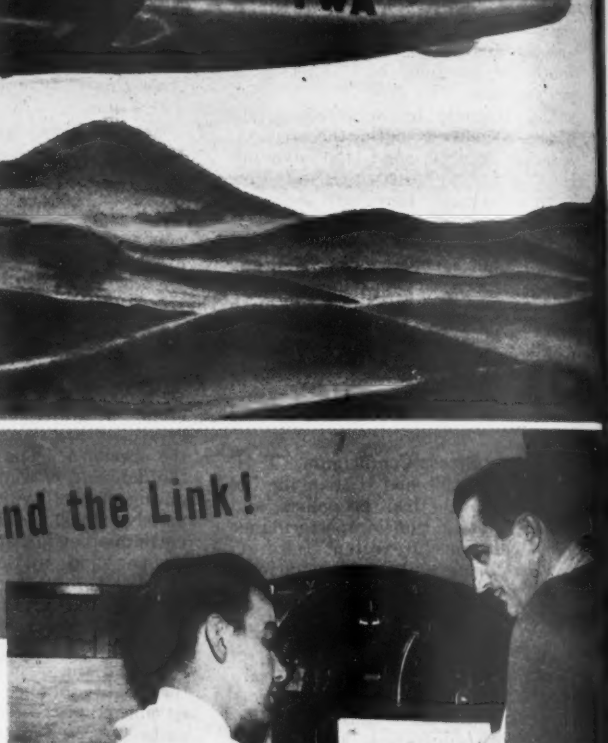

TWA LINK INSTRUCTOR, AL MUTCHLER, *checks a "let-down" chart with a student of instrument flying. Formerly Link Instructor for the R.A.F., Mutchler trained many of the Ferry Command pilots who made the first vital deliveries of bombers overseas.*

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the aircraft turntable perfected by the Haughton Elevator Company to enable the checking of magnetic compasses, gun sights, and hydraulic systems. It is explained that to check the magnetic compass the tests must be made with the engines running at cruising speed, the landing wheels retracted, and other conditions the same as when the airplane is in flight. Problems connected with the construction of the turntable are outlined. *Aviation and Yachting*, June, 1944, pages 29, 67, 2 illus.

Testing Equipment

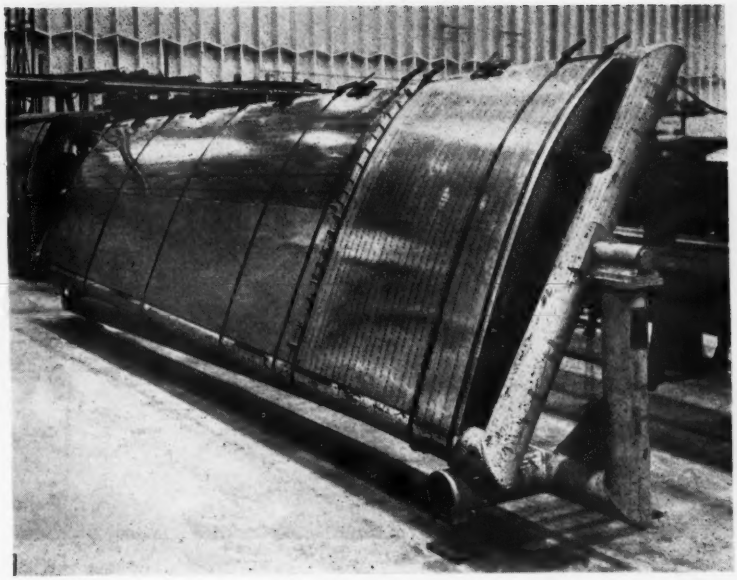
Regenerative Dynamometers. A description of dynamometer installations made by The English Electric Company, Ltd., for the regeneration of electric power from aircraft engines under test. These electrical dynamometers are of the swinging-frame torque-reaction direct-current type, the field system of which is supported in trunnion bearings. A torque-weighing mechanism is provided which is arranged to give remote indication of the torque. Because of requirements arising from the possible future need for testing engines fitted with reduction gears for counter-rotating propellers, each dynamometer consists of two units. The inner unit, adjacent to the engine, has a hollow shaft through which an inner shaft is led and coupled to the solid shaft of the outer dynamometer.

To convert the power generated by the direct-current dynamometers into a form suitable for regeneration into the alternating-current supply service, The English Electric Company has adopted the Ward-Leonard system. This system involves the use of a motor-generator set consisting of a synchronous alternating-current machine and two direct-current machines, each of which is coupled electrically to one unit of the dynamometer. The article explains its operation and advantages. Details are also included on the special unit test with maximum operating speeds of 5,000 r.p.m., which have been supplied for research and experimental work on twin-cylinder Napier Sabre engine units. *Aircraft Production*, June, 1944, pages 259–261, 5 illus.

Camera Recorders. Details are given on the photographic equipment used by Hawker Aircraft, Ltd., for automatically recording the results of test flights. The complete unit is described as consisting of a box containing the usual aircraft instruments, a number of Desyn remote indicators, lights for illuminating the instruments, and a camera for photographing them.

A Pathoscope II, which takes 600–700 frames on 9.5-mm. film, is the camera used for the recorder. *Flight*, May 18, 1944, pages 532, 533, 6 illus.

Heating, Piping, and Air Conditioning Involved in Testing Airplane Engines. F. O. Jordan. A general survey is given of the facilities required for testing airplane engines. It is shown that heating, piping, and air conditioning and their practical applications all are involved. Air must be supplied in large quantities and in the proper conditions to cool the engines and to simulate actual wartime and peacetime operations. Extensive piping services, which include gasoline, oil, steam, and water, must be provided. Suggestions are made for the design of such facilities. *Heating, Piping & Air Conditioning*, June, 1944, pages 346–349, 3 illus.



The three-point support on this trunnion fixture does not transmit strains into the framework of the main assembly fixture.

Tools and Equipment

Precision Jig Control. The purpose, construction, operation, and advantages of the Aircraft Jig Collimator are explained. An adaptation of the surveyor's transit, this tool is used for the alignment of points on jigs, which control the size, shape, and interchangeability of aircraft components.

While projecting optical lines, the device does not include the graduated circles used by the surveyor but unnecessary in aircraft tooling. The Jig Collimator was devised by a member of the Douglas Aircraft Company's tooling department. *Southern Flight*, June, 1944, pages 32, 33, 3 illus.

"Milking-Stool" Fixtures Are Steady, Sturdy and Stiff. A. C. Edmiston. To solve the problem of uneven or changing floors, Ryan Aeronautical Company designs its fixtures with three supporting points. This article contains details on the construction of this type of fixture and the tubular sections used for its manufacture. The advantages of rigidity, accessibility, and convenience are indicated. *Wings*, July, 1944, pages 1103–1105, 7 illus.

Improved Presses for Aircraft Sheet Metal Forming. Russell Powell. The construction and operation of several improved types of sheet-metal forming presses manufactured by The Hydraulic Press Manufacturing Company are detailed. Among the machines described are: a Fastraverse deep-drawing press for forming airplane upper-tank sections; a smaller press of the same type for drawing smaller parts; a deep-metal drawing press with blank-holder and die cushion; a self-contained hydraulic press, equipped with rubber pad, for shallow forming and flanging operations; a sheet-metal stretcher; an "all-hydraulic" forging press; a forging press for flat die forging; and a closed-die forging press of 2,000-ton capacity. *Aero Digest*, June 15, 1944, pages 86, 87, 138, 6 illus.

Continuous Heat Treatment of Aluminum. J. O. Laws. Construction and operating data are furnished for a large aluminum heat-treating furnace designed to approximate continuous operation. The unit is used by the Texas Division of North American Aviation for processing aluminum parts for Liberator bombers. It is stated that the furnace is probably the largest, and gives the nearest approach to fully automatic heat-treating, in the aircraft industry. *The Iron Age*, June 22, 1944, pages 58–60, 126, 3 illus.

Servicing Civil Aircraft. Part II. Further examples of the special testing gear that has been designed and developed by the British Overseas Airways Corporation are described. These include a machine for testing automatic pilots and undercarriage retractions on any type of aircraft, a universal engine and power-egg sling, universal engine stands, a spark-plug overhaul and testing bench, a universal instrument test rig, and a thermometer testing unit. *The Engineer*, May 5, 1944, pages 353–355, 10 illus.

Coated Fiberglas* Fabrics

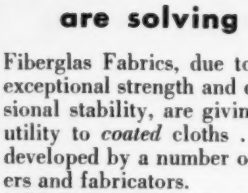
are solving many problems, today

Fiberglas Fabrics, due to their exceptional strength and dimensional stability, are giving new utility to *coated* cloths . . . as developed by a number of coaters and fabricators.

Made from Fiberglas Fabrics —coated on one or both sides with natural or synthetic rubber, vinyl compounds or other coating materials—these coated cloths have helped solve many wartime problems. They are, for instance, used in the fabrication of gun-bore sight screens, brilliant colored markers, sails, protective coverings such as battery covers, thermal insulation covers, oil-resistant covers, flexible connections. Experimental uses include fuel storage bags and distillate tanks.

While the characteristics of these coated cloths differ with the type of coating applied and the manner of application, all acquire some highly essential quality from the Fiberglas Fabric base. These Fiberglas Fabrics are woven from extremely fine, continuous fibers of glass . . . inorganic, chemically stable, incombustible, neither shrinking nor stretching under changes in temperature and humidity, combining great tensile strength with light weight.

Such a combination of qualities has had a strong appeal to fabricators and users of coated cloths. Almost daily some potential use of this amazing and versatile material is being suggested.



Design Engineers are invited to write

While much remains to be learned about the potentialities of coated Fiberglas cloths, coaters and fabricators now have considerable data on their manufacture and applications. Should you care to know more about these fabrics, write, describing what characteristics you desire in the finished material.

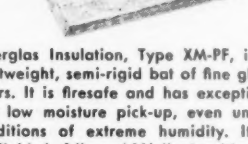
Owens-Corning Fiberglas Corporation, 1893 Nicholas Bldg., Toledo 1, Ohio. In Canada, Fiberglas Canada, Ltd., Oshawa, Ontario.

OTHER AIRCRAFT USES OF FIBERGLAS

Made by combining certain low-pressure resins with Fiberglas—glass in the form of fine fibers—these materials provide great strength with light weight; exceptional ability to absorb shock; dimensional stability under moisture changes. These and other properties of this amazing new structural material are described in a booklet of reprints of articles which appeared recently in "Modern Plastics". Write for your copy.

Fiberglas Insulation, Type XM-PF, is a lightweight, semi-rigid bat of fine glass fibers. It is firesafe and has exceptionally low moisture pick-up, even under conditions of extreme humidity. It is available in 1 lb. and 1½ lb. densities. In aircraft construction it is used for acoustical and thermal insulating purposes.

Another type of Fiberglas thermal insulation, these fireproof blankets (known as Design No. 3) are made of Fiberglas Insulating Wool, Type N, faced with Fiberglas Cloth and stitched with glass thread. Available in 1½ lb. and 3 lb. densities, they are extensively used to insulate gasoline heater exhausts, heat exchanger ducts, other high temperature pipes, etc.



Another all-glass product—woven from Fiberglas yarns. While extensively used for insulating motors, generators and other electrical equipment, many other applications have been found for these durable, incombustible tapes in aviation —such as covering of thermal insulations on hot air ducts, ties for removable insulating pads, etc.

FIBERGLAS ..A BASIC MATERIAL

*T. M. Reg. U. S. Pat. Off.

Training

Aeronautical Relationships with the E.C.P.D. Howard W. Barlow. One of the subjects discussed in this article is the relationship of the inspection committee of the Engineers' Council for Professional Development to the institution being examined for accrediting. Advantages that might be gained if at least one member of the Committee were familiar with aeronautical engineering are outlined.

Consideration is given to the desirability of maintaining, in the postwar era, the present policy of the Committee on engineering schools in the light of industry's experience with short-term, intensive, terminal courses. Final paragraphs discuss the maintaining of the integrity and individuality of the aeronautical engineering curriculum as a professional curriculum and establishing relationships with the E.C.P.D. on a more representative basis. *The Journal of Engineering Education*, January, 1944, pages 392–394.

Aircraft Engineer Training. Recommendations of the Society of British Aircraft Constructors for the training of aircraft engineering apprentices are outlined. Separate syllabuses are listed for the aircraft apprentice and for the engine apprentice. These cover both general training and advanced specialization for those who qualify. *Flight*, May 18, 1944, pages 534, 535; "Training Aircraft Engineers," *Aircraft Production*, June, 1944, page 291.

A Revision of the Aeronautical Engineering Curriculum in the Light of Modern Aircraft Engineering Requirements. C. T. Reid. The writer outlines modern airplane-engineering requirements and considers how education and training can satisfy the requirements. A suggested college curriculum for the Bachelor of Science degree in aeronautical engineering is presented in tabular form. Other subjects suggested for elective or postgraduate study are listed. *The Journal of Engineering Education*, January, 1944, pages 486–491.

Campus in the Sky. William F. McDermott. An account of the course of aviation training given at Stephens College, Columbia, Mo. Students at this women's college can take a full departmental program, "majoring" in aviation. Information is offered about the various studies included in the curriculum, the faculty, equipment and facilities, the sequence of instruction, the number of girls taking the courses, and plans for future "flying classrooms." *Collier's*, July 8, 1944, pages 22, 23, 7 illus.

Training for Production Engineering in the Aircraft Industries. M. J. Thompson and John C. Bowman. The training of aircraft engineers to satisfy war production requirements is discussed with particular reference to the educational activities of the University of Texas. An outline is given of the University's full-time Engineering Defense Training course in aeronautical engineering, and data are given to indicate its effectiveness. Information and data also are included concerning the University's Engineering, Science, and Management War Training Program in aeronautical engineering now in progress. *The Journal of Engineering Education*, January, 1944, pages 547–555.

The Student Pilot and the Controls. Wolfgang Langewiesche. The concluding one of two articles in which the writer suggests improved methods for instructing the student pilot in the use of the stick, rudder, and throttle. Having considered the rudder in Part I, in this installment he is concerned with the elevator and the throttle. He criticizes present methods of interpreting the functions of these controls for the student and offers advice on how the student should be instructed in their use. Six rules are formulated for helping the student understand more clearly how the airplane responds to the elevator and the throttle. The writer also proposes new arrangements for these controls in the cockpit and new nomenclature for them. *Air Facts*, July, 1944, pages 40, 41, 44, 46–48, 50–52, 54.

What Can the Engineering Schools and the Aircraft Industries Do to Develop More Effective Engineering Personnel? A. S. Levens. Seven proposed solutions to the problem of meeting the engineering personnel requirements of the armed forces and industry are discussed. *The Journal of Engineering Education*, January, 1944, pages 626–632.

Aeronautical Training. Martin Sharp. An account of the structure, work, and objects of the de Havilland Aeronautical Technical School, which has served British industry for 16 years, a quarter of that period having been under war conditions. The history of the first 10 years of the school is traced briefly, with comments on the effects of war. Particulars are given concerning the requirements for entrance, the student body, apprenticeship, scholarships, and the courses offered, as well as the mechanical facilities of the school. Charts show the organization and curriculum, and photographs illustrate many phases of the operation of the institution. The account is followed by a brief statement of other aeronautical educational facilities now available in England. *Aeronautics*, June, 1944, pages 28–34, 19 illus.

Aeronautical Engineering Curricula and Its Relation to Present and Future Needs of the Industry. E. S. Kavanaugh. It is stated that while the first two years of aeronautical engineering should be basically the same as that taught to other engineering students, the applications as brought out in class could be revised. Such subjects as physics and drawing could be taught from the aeronautical engineering standpoint. The descriptive geometry could be revised to include a study of lofting problems. The plane surveying course could be revised or dropped. If the strength of materials and mechanics courses could be taught more thoroughly, more advanced work could be taken in the aircraft structures courses. The importance of instructive courses in flight is discussed. *The Journal of Engineering Education*, June, 1944, pages 686–689.

Warfare

Strategic Implications of the Defensive in Air War. Peter Marsh Stanford. It is noted that in less than 50 years one type of military machine—the airplane—has been brought to such a stage of development that the entire character of warfare is modified. Reference is made to a school of air war theorists which maintains that the air arm, more than being an important new weapon of war in battle, is decisive and all-determining in all battles. Out of this idea grew the doctrine of the air offensive, which stated that victory in modern warfare depended on the air offensive alone. Knowledge gained from actions in the present war are reviewed. It is concluded that there exists a balance of offense and defense in the war in the air, as in any other field of conflict. This balance should be manipulated to the advantage to be drawn from the particular situation. A powerful air offensive will play an important part in gaining victory. The task of the land forces in defeating the enemy will be lightened by a powerful air offensive. It is held, however, that sea power, not air power, remains the backbone of the great coalition effort against the Axis. *United States Naval Institute Proceedings*, June, 1944, pages 625–635.

Bombing Policy. James Barlow. The effectiveness and method of Royal Air Force bombing attacks on Germany are defended. On points of bomb load, sighting, range, armament, and avoidance of congestion in the air, the writer indicates the value of night raids. He also justifies the Royal Air Force policy of continually attacking the same target. *Flight*, May 18, 1944, page 531.

Welding

The Dynamic Properties of Flash-Welded Tubing. R. B. Bland and P. E. Sandorff. A report on a series of tests of welded tubing, conducted to determine the reduction in the dynamic strength that could be expected as a result of the use of the flash-welding process. The first part of the report describes tests made to determine the effect of flash welding and of arc welding on the impact strength of $1^1/_2 \times 0.065$ wall X-4130 tubing in various heat treatments. The apparatus, specimens, and test procedure are described in detail with tables and drawings. Conclusions are as follows: (1)

(*Continued on page 185*)

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No part is too small or too large for the complete Reynolds facilities. All parts are subjected to rigid inspection as a normal routine of manufacture and stamped with the customer's assembly code numbers. Carefully compiled tally sheets systematically record the shipment of all parts. There is no confusion or delay in assembling Reynolds parts.

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Reynolds facilities are complete in every respect . . . from the bauxite mines to finished aluminum parts. Batteries of modern high-speed machines, manned by skilled operators, are now available to manufacturers with suitable allocations.

Parts can be fabricated to the most strict specification, or when desirable, Reynolds engineers are ready to work with manufacturers to determine the best application of the new Reynolds-developed aluminum alloys to the specific job at hand. No part is too large or too small for the Reynolds production facilities.

Why not investigate what Reynolds can do for you *now*? Reynolds Metals Co., Aluminum and Parts Div., Louisville, Kentucky.

* * *

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Government Publications

Army Air Forces

American War Planes. A series of 22 brief descriptions of current types of American military aircraft includes specifications under the headings of description, dimensions, power plants, armament, performance, protection, and bomb loads (in the case of bombers). Brief comments also are given concerning particular services rendered by each type of airplane. *A.A.F. Materiel Command*, Wright Field.

Cluster Bombs. The cluster bomb consists of a number of small fragmentation bombs strapped together to form a single bomb and carried in any service bomb rack. Upon release, an arming wire automatically severs the bands that hold the bombs and the cluster breaks apart in the slipstream. Then, in a dispersed pattern, the individual bombs stabilize and drop on the target. As they hit and explode, the shrapnel covers an area 200 ft. wide on both sides of the line of flight. Highly effective against planes parked at enemy airdromes, the shrapnel "scatter" is also deadly when used as an antipersonnel bomb dropped into troop concentrations.

The effectiveness of single fragmentation bombs dropped from light bombers with special bomb racks was recognized by A.A.F. specialists as early as 1940. Foresight dictated the use of these bombs in quantity by long-range bombers heretofore equipped to carry only large demolition bombs. The Matériel Command was assigned the tasks of devising a method by which heavy loads of small bombs could be carried and dropped by long-range bombers.

Various bomb-chute arrangements proved unsatisfactory because small bombs, suspended individually and released simultaneously, required special bomb racks and had the characteristic of colliding and exploding an instant after release. Armament specialists of the Matériel Command next developed the successful cluster idea. It was found that the cluster could be installed in any standard bomb rack and that the bombs fell in a most effective pattern. The cluster device is also adaptable for use with 4-lb. incendiary bombs. *A.A.F. Matériel Command*, Wright Field.

Bureau of Aeronautics

Thunderstorms is a booklet of 38 pages, listed as Number 2 in the "Aerology Series." It is prepared to help naval air students to understand thunderstorms. It is intended to give some idea of the phenomena that precede thunderstorms, how they are formed, and what causes them. It includes also some general rules for flying near and through thunderstorms and some advice from the experiences of meteorologists and Navy and air-line pilots. No attempt is made to instruct students how to fly in individual storms.

The booklet contains a group of 16 rules, illustrated by sketches. A short glossary gives definitions of a few common terms in meteorology. *Training Division, Bureau of Aeronautics, U.S. Navy*, price $0.10.

Army Service Forces

Index to Army Regulations, AR 1-5 includes all regulations and changes promulgated prior to January, 1944.

It includes Army Regulations that have been suspended but not recinded. Amendments to the regulations have been indexed without citing the medium of change. Subjects have been indexed under specific name titles. Cross references of such specific main titles are made under general name headings. Several headings not previously included in the Index of Army Regularions have been added as follows: Board, and Board of Officers; Definitions; Forms; Illustration; Reports; School. *Prepared under direction of the Adjutant General*, 540 pages, for sale by the Superintendent of Documents, Washington, $0.60.

The Chaplain Serves. In a booklet telling about the work of Army Chaplains, a section is devoted to the specific activities of Chaplains in the Air Forces. Briefly reviewing the establishment of the Air Chaplain Division and the development of the Chaplain program throughout the various branches of the Air Forces, it reports on how many members of the clergy were serving with the Army Air Forces in the United States at the end of 1943. *Office of the Chief of Chaplains, Army Service Forces, War Department.*

Bureau of Naval Personnel

Gas! Know Your Chemical Warfare. Six lectures on chemical warfare are contained in this pamphlet. They cover the rudiments of gas identification, personal protection, matériel and tactics, and decontamination. Using discussion, line drawings, and charts, the pamphlet presents the important principles of defense, and briefly describes offensive measures in chemical warfare. *Navpers 15039, Bureau of Naval Personnel*, Washington, $0.25.

Bureau of Ships

Instructions for the Operation and Maintenance of Electrical Measuring Instruments constitutes Chapter 69 of the *Bureau of Ships Manual.* It is divided into six main sections: uses and classifications; description and special precautions; adjustment, accuracy, and checking; precautions; care; repairs. *Bureau of Ships*, 22 pages, for sale by Superintendent of Documents, Washington, $0.10.

Instructions for the Operation and Maintenance of Mechanical Measuring Instruments constitutes Chapter 87 of the *Bureau of Ships Manual.* It is divided into nine sections as follows: gauges and gauge-testing apparatus; revolution counters; tachometers; tank-level indicators; torsion meters; manometers; thermometers; salinometer sets; apparatus for analyzing gases of combustion. *Bureau of Ships*, 26 pages, for sale by the Superintendent of Documents, Washington, $0.10.

Civil Aeronautics Administration

C.A.A. Aircraft Fabric Tester. A *Description and Manual* has been published in mimeographed form relating to a mechanism for testing fabrics. The purpose of the device is to provide field inspection personnel with a mechanical means for determining the airworthiness of doped-fabric aircraft surfaces without damage to such fabrics that may be in good condition. It outlines the procedure followed in the development of the device and gives descriptions of the instrument itself and of the tests made by it. The conclusions indicated by the tests are included and a discussion is given of the results of the work.

The Correlation of Aircraft Take-Off and Landing Characteristics with Airport Size. A. L. Morse. A report on a study made for the purpose of establishing a fundamental basis for the determination of airport dimensions that will accommodate safely the operation of aircraft. The study involved the obtaining of adequate and pertinent data and the interpretation of these data in the form of recommended dimensional requirements for airports. It was believed important

Looks good . . . but will it run?

There was once a day when "Will it run?" was really a serious question in the minds of most prospective automobile buyers.

What has made the difference between those times and the recent years of big production, when assembly lines poured forth thousands of cars daily . . . all standardized down to the smallest part . . . all ready to start promptly, run smoothly and *keep on* running?

It has been the enthusiasm, the inventiveness, the drive, energy and ingenuity that has always marked the men of the automotive industry. It has been the urge for betterment that has inspired great engineering advances and startling improvements in production techniques.

And, contributing in no small measure, came precision building of automotive parts in quantity, so that each of many thousands of well-engineered interchangeable parts fitted exactly into its place and functioned exactly as it should.

Eaton engineers worked closely with the automotive engineers through this 30-year period of development—and helped to solve the many problems involved in producing *Quality in Quantity.*

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SUPPLIERS OF FINE PRECISION PARTS TO THE AUTOMOTIVE AND AIRCRAFT INDUSTRIES FOR MORE THAN THIRTY YEARS —NOW, AND TILL VICTORY IS WON, DEVOTING OUR ENTIRE FACILITIES AND RESOURCES TO WAR WORK.

that these dimensions be founded, as far as possible, on data that indicated how airplanes actually perform under ordinary conditions rather than on an assumed standard of performance. For this reason, the study was based mainly on photographic records of day-in and day-out operations of a number of representative airplanes, obtained at various altitudes and at various airports. In addition to performance data, the study includes a large number of accident records and meteorologic observations through which the photographic records were translated into airport dimensions. *Technical Development Report No. 40*, April, 1944.

Civil Aeronautics Board

Annual Airline Statistics; Domestic Carriers; Calendar Years 1938–1942 is a compilation of comparative statistical data relating to the commercial operations of the domestic air carriers during the calendar years 1938–1942. It includes comparative summaries of the financial operations of each of the domestic carriers during the period, the mileages flown, and the amount and types of traffic carried, as well as data concerning the utilization of aircraft and other related information. The material is given individually for each of the carriers and is recapitulated to provide similar information for the domestic air transport industry as a whole. Information relating to the war activities of the carriers during the latter part of the period has been excluded.

The figures are given in the form of eight tables, the first three of which contain operating statistics, a comparative summary of operating expenses, and a comparative statement of balance-sheet accounts. The fourth table gives an analysis of passenger-miles flown, and the fifth, sixth, seventh, and eighth tables include comparative statements of aircraft performance factors, aircraft utilization, aircraft in service, and numbers of employees and their compensation. *Economic Bureau, Rates and Audits Division*, 139 pages, price $0.50.

Civil Aeronautics Board Reports: Decisions of the Civil Aeronautics Board. Volume No. 2 of the *Civil Aeronautics Board Reports* covers the period from July, 1940, to August, 1941. It gives the decisions made by the Board during that time. An index tabulates the cases cited; another lists the cases reported. For sale by the Superintendent of Documents, Washington, $1.50.

Department of Agriculture

Progress Reports of the Forest Products Laboratory. Additional reports have been made available in the series about wood materials and their uses in aircraft construction. The reports constitute a series issued in cooperation with the Army-Navy-Civil Committee on Aircraft Design Criteria under the supervision of the Aeronautical Board.

No. 1327-A is a supplement to a previous report about the fatigue behavior of wood, "Fatigue Behavior of Douglas-fir and Sitka Spruce Subjected to Reversed Stresses Superimposed on Steady Stresses." No. 1530 is titled "Summary of Information on the Durability of Aircraft Glues." No. 1598 refers to "Moisture Excluding Effectiveness and Weight of Aircraft Finishes on Papreg and on Plywood." No. 1599 is on "Aircraft Veneers in Yellow Birch, Hard Maple, Yellow-Poplar, and Sweetgum."

No. 1442 is a reprint of an article "Wood's Technological Coming-of-Age" by F. J. Champion. "A List of Publications on the Seasoning of Wood," issued January, 1944, is numbered R446. These reports were prepared in cooperation with the University of Wisconsin. *Forest Service, Forest Products Laboratory*, Madison, Wis.

Department of Commerce

Supplementary List of Publications of the National Bureau of Standards has been published as a supplement to Circular C24. This supplement, accompanied by brief abstracts, lists the publications of the National Bureau of Standards from January 1, 1932, to December 31, 1941. The consolidated subject and author indexes are for all publications of the Bureau from 1901 to December 31, 1941. This complete material gives in one place the references to the results published by the Bureau on a particular subject and by a given author. For Simplified Practice Recommendations and Commercial Standards the title listings are complete. These publications are subject to frequent revision by the industries concerned, and the references to them in some cases may be to editions later than December 31, 1941. *National Bureau of Standards*, 386 pages, for sale by Superintendent of Documents, Washington, $0.50.

National Advisory Committee for Aeronautics

Comparative Results of Tests on Several Types of Nozzles, by M. S. Kisenko. (Translation of Report No. 478 of the Central Aero-Hydrodynamical Institute, Moscow, 1940.) This paper presents the results of tests conducted to determine the effect of the constructional elements of a Laval nozzle on the velocity and pressure distribution and the magnitude of the reaction force of the jet. The effect was studied of the shapes of the entrance section of the nozzle and three types of divergent sections—namely, straight cone, conoidal with cylindrical end piece, and diffuser, obtained computationally by a graphic method credited to Prof. F. I. Frankl. The effect of the divergence angle of the nozzle on the jet reaction was also investigated. The results of the investigation showed that the shape of the generator of the inner surface of the entrance part of the nozzle essentially has no effect on the character of the flow and on the reaction. The nozzle that was obtained by graphic computation assured the possibility of obtaining a flow for which the velocity of all gas particles is parallel to the axis of symmetry of the nozzle, the reaction being, on the average, 2 to 3 per cent greater than for the usual conical nozzle under the same conditions. For the conical nozzle the maximum reaction was obtained for a cone angle of 25° to 27°. At the end of this paper a sample computation is given by the graphic method. The tests were started at the beginning of 1936 and this paper was written at the same time. *N.A.C.A. T.M. No. 1066*, June, 1944.

Navy Department

Benefit Guide for Officers and Enlisted Personnel. A leaflet of 18 pages gives in tabular form detailed information about the benefits to which dependents of officers and enlisted personnel of the U.S. Navy and U.S.N.R. may be entitled. It is intended solely as a guide and does not cover all cases that may arise. It shows the specific benefits provided, the conditions under which the benefits are guaranteed, a detailed explanation of the benefit and its method of operation, a list of the papers necessary to substantiate the claim, and the name and address of the agency having jurisdiction. *Bureau of Naval Personnel, Welfare Division, Casualties and Allotments Section.*

New York State Education Department

Suggested Unit Course in Glider Ground Trainer Construction, prepared at the National Defense Curriculum Laboratory, Cornell University, Ithaca, N. Y. To help meet the need for suitable instructional material for the training of aircraft woodworkers, a program was carried on in 1943 at Cornell University for the training of aircraft-woodworking teachers, at which a group of skilled teachers of woodworking was recruited and given intensive instruction in the application of woodworking in aircraft building. Working in close cooperation with this teacher-training course, the National Defense Curriculum Laboratory at Cornell undertook the development of instructional material on glider construction. This book, with the working drawings that accompany it, is the result of this project.

Today, at Hawthorne, Northrop is turning out another "first"... the first U. S. warplane designed specifically for night fighting!

The Black Widow carries a skipper *and a crew* . . . is the largest, most powerful fighter plane ever built.

It can "smell out" enemy planes in the dark like a hound dog—hit them "from nowhere" with the shattering power of 20 millimeter cannon and 50 calibre machine guns.

With the range and heft of a medium bomber, the power of a Diesel locomotive, the Black Widow has fighter speed. Yet it's sweet to handle, safe to fly. It's hard to spin from even the tightest turns. It takes off fast . . . lands so slowly it sets down safely in the dark on small fields.

The Black Widow is built on four years of battle knowledge and long-recognized Northrop skill and craftsmanship.

And as the Northrop group is producing the new P-61 for this year's battles . . . Northrop is pioneering still more advanced planes for tomorrow.

NORTHROP *Designers and Builders of the* ***BLACK WIDOW P-61 Night Fighter***

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The ground trainer used for preflight training for the glider pilots was selected as the project for the training program. It is towed behind an automobile and does not leave the ground. It is designed and built in such a manner that it gives the prospective pilot the same problems in operating the rudder, elevator, and ailerons as will be encountered in real glider or power plane flying.

This book is a series of job sheets for the building of a glider ground trainer. It is intended to be used in connection with the ten working drawings included, giving all the necessary details for the construction work. Each of the job sheets contains a list of materials recommended for that particular subassembly, together with suggestions in some cases for substitute materials that can be used.

An appendix contains a list of materials needed for the construction of the ground trainers and a list of shop equipment needed. A section dealing with the operation of the completed ground trainer is also included. *Bureau of Industrial and Technical Education*, Albany, N.Y., 1943, 194 pages, $3.50.

Vocational Education Program for National Defense Industries. Seven ring-bound volumes comprise a series of manuals prepared to assist teachers in conducting classes in vocational schools for the intensive training of aircraft workers. The books are intended for specialists assigned by industrial establishments to the work of instructing prospective employees under the emergency program in cases where previous teaching experience is lacking. They were prepared by the Industrial Teacher Section of the Bureau of Industrial and Technical Education with the assistance of supervisors and committee members from various vocational schools and from aircraft companies in the state.

Each of the first four books in the series contains three instructional units consisting of supplementary information, fundamental processes, and job sheets. The instructor may use the unit lessons to supplement his teaching in connection with a given job. The supplementary information units may be used to develop lesson plans for related shop talks, while the fundamental process units may be used as a guide in giving shop demonstrations. The job sheet units provide the instructor with a series of planned jobs which are definite units of work to be done. At the same time these jobs motivate the teaching of fundamental processes and accompanying supplementary information. The lesson units in the supplementary information series deal with the "Why to Do" and are directly related to fundamental process or "How to Do" units.

The fundamental process units were selected on the basis of covering the range of operations suited to the needs of beginners in Aircraft Riveting. They contain basic airplane construction processes that deal with the "How to Do." The purpose of these units is to develop fundamental trade skills. They are arranged in the order of learning difficulty with each process introducing new information and skill.

The job sheet units deal with the "What to Do." They consist of a series of jobs which have been selected to make certain the mastery of definite skills. These units include a drawing of the part or assembly to be riveted, a list of the operations to be performed, and a cross reference to the supplementary information units ("Why to Do") and the fundamental process units ("How to Do").

Included in this course of study is an outline that covers the range of teachable material on the beginner level. Although the units of instruction are arranged in a logical teaching order, as indicated by the table of contents, the topics in the outline are arranged so as to point out the scope of the work without particular reference to the order in which the "Why to Do," "How to Do," or "What to Do," units appear.

The foregoing manuals are titled: *Suggested Unit Course in Riveting for Beginners in Aircraf Metal Work* ($1.35); *Suggested Unit Course in Assembly for Beginners in Aircraft Metal Work, Part I, Bench Assembly* ($1.60); *Suggested Unit Course in Fabrication for Beginners in Aircraft Metal Work* ($1.60); *Suggested Unit Course in Assembly for Beginners in Aircraft Metal Work, Part II, Sub, Line, and Final Assembly* ($1.50).

The fifth volume in the series is *Suggested Laboratory Course in Inspection Practice* ($1.10). It was prepared for the training of inspectors in the field of aircraft manufacture with particular reference to the inspection of machined parts, tools, and gauges.

The sixth manual in the series is titled *Factory Production Methods Applied to Aircraft Teaching* ($1.50). It is intended to make instructors acquainted with actual production methods, under a plan whereby a full-size airplane unit such as a fin or stabilizer is constructed. When the part is finished it is used as an inspection project, and after its inspection it is used in the teaching of subassembly. After that it is returned to the inspection class for checking, and then it is used in final assembly in the construction of the complete unit. Sections of the book relate to each individual operation in the production of aircraft parts, and the illustrations show production methods in their proper sequence.

The seventh unit in the series is prepared for the teacher of classroom work in inspection practice. It is titled *Shop Talks on Inspection* ($1.25), and it contains a series of outlines for shop talks or classroom work dealing with many of the more important types found in inspection practice.

It is not intended that this series should be used in its entirety as a course of study. Certain of the topics pertain primarily to the inspection of machined parts and others pertain to tool inspection or to special aspects of inspection practice in the manufacture of aircraft. *Bureau of Industrial and Technical Education.*

Office of Defense Transportation

Transportation Training. Offering information to transportation officials regarding the training of personnel, this is the second Bulletin published by the Personnel Training Section of the Division of Transport Personnel, Office of Defense Transportation. It tells of the Federal war-training agencies and advises how their activities can be of service to transportation companies in helping to solve some of their personnel-training problems. *Bulletin No. 2, Personnel Training Section, Division of Transport Personnel.*

War Department

Arctic Manual. Written especially for Army personnel who will have to travel in the Arctic region and live away from permanent posts, this manual deals particularly with Arctic North America. Some sections contain information of value to anyone stationed within the Arctic or Sub-Arctic region. The manual is divided into two sections, one describing the character of the Arctic country; the other, living in the Arctic region. *Technical Manual TM 1-240*, January, 1944, for sale by Superintendent of Documents, Washington, $0.25.

The British Admiralty

The Royal Marines. Preceded by a brief outline of the Royal Marines' organization, functions, and traditions, this is an Admiralty account of their exploits and achievements from 1939–1943. Among the operations recorded are those that took place in Iceland, Norway, Holland, France, Crete, Singapore, Malaya, Madagascar, Malta, and Sicily. Published by His Majesty's Stationery Office, London, 9*d*; British Information Services, New York, $0.25.

British Air Commission

Progress of United Kingdom Aircraft Production. A review is given of the activities of the aircraft industry in the United Kingdom, with figures showing the current production compared with past years. Information is also given about the progress that has been made in the design and performance of British aircraft. A table is included showing the number of new aircraft produced, aircraft repaired, and engines produced in the first year of the war compared with the year ending March 31, 1944. Another table classifies into operational and trainer groups the total number of aircraft produced in the years 1936 through March 31 1944, giving the weight in thousands of pounds and the percentage of trainers to the total number of aircraft. It shows that in the

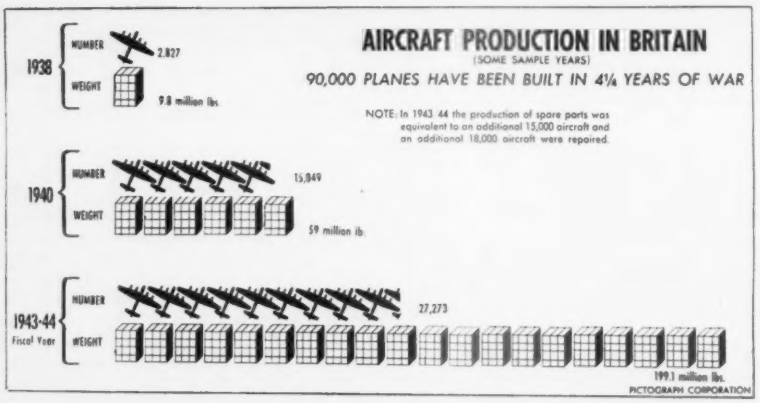

Illustration Courtesy British Information Services

year 1944 27,273 airplanes were produced, of which trainers amounted to 17 per cent, compared with, in 1936, 1,830 airplanes, of which 52 per cent were trainers.

British Air Ministry

There's Freedom in the Air. The story of England's European allies who are fighting side by side with the Royal Air Force. It portrays the spirit of the people whose countries have been destroyed and whose governments have been driven into exile or suborned. The booklet is divided into six sections titled: They Wanted to Go on Fighting; Escape to Action; In Defence of Britain; The Bright Strings of Vengence; Wings for Freedom; Circle of Faith, Circle of Arms. Prepared by the Ministry of Information, His Majesty's Stationery Office, London, 6*d.* net.

British Information Services

Note on the Effect of Compressibility on Jones' Momentum Method of Measuring Profile Drag. A. D. Young. A discussion is given of modifications to the theory of Jones' momentum method of measuring profile drag to allow for compressibility. A first-order correction term applicable to the incompressible-flow formula for profile drag is evaluated. It is estimated that this correction term adequately measures the effect of compressibility at speeds about 350 m.p.h. and can probably be applied with fair accuracy at still higher speeds. Average values for the correction at various speeds are as follows: 100 m.p.h., −0.5 per cent; 200 m.p.h., −2.0 per cent; 300 m.p.h., −4.5 per cent; 350 m.p.h., −6.0 per cent. Details of the calculations are given in an appendix. *Ministry of Aircraft Production, Aeronautical Research Committee, R. & M. No. 1881*, British Information Services, New York, $0.60.

British Medical Research Council

The March issue of the *Bulletin of War Medicine* contains abstracts of papers dealing with a wide variety of subjects connected with war medicine. One section is given to the special field of aviation medicine. The papers abstracted in that section are: "Otitic and Sinus Barotrauma," by J. G. Mackenzie; "A New Method for Treatment of Acute Aero-Otitis Media," by R. H. Wiseheart; "Tooth Temperature, with Reference to Dental Pain while Flying," by W. Harvey; "Toothache and the Aviator—A Study of Tooth Pain Provoked by Simulated High Altitude Runs in a Low Pressure Chamber," by T. V. Joseph, C. F. Gell, R. M. Carr, and M. C. Shelesnyak; and "Acceleration of Co-ordinated Muscular Effort by Nicotinamide—Preliminary Report to the Medical Research Council," by I. M. Frankau. His Majesty's Stationery Office, London, 1*s.* 3*d.*

British Ministry of Aircraft Production

Revised to February, 1944, a current booklet contains notices and lists of new translations available from the scientific and technical press. It includes the titles and other reference information about articles concerning the aeronautical sciences appearing in publications of various countries. The list is classified according to a variety of subjects for ready reference. The main headings are: Theory and Practice of Warfare; Aerodynamics and Hydrodynamics; Aircraft, Airscrews and Accessories; Engines and Accessories; Fuels Materials; Instruments; Production; Transport; Wireless and Electricity; Light and Heat; Photography; Meteorology; Physiology and Aviation Medicine; Mathematics and Physics. *Directorates of Scientific Research and Technical Development, R.T.P. 3.*

British Ministry of Labour and National Service and the Ministry of Production

Sightless Aircraft Workers. A review is given of the kinds of work for which blind persons have been employed with satisfactory results in aircraft production. How the workers were trained and the high degree of proficiency attained are emphasized. Changes made in adapting machine tools for operation by sightless workers are described. *Production and Engineering Bulletin*, June, 1944.

British Air Ministry Translations

The list below supplements those published in previous issues of the AERONAUTICAL ENGINEERING REVIEW.

Aeronautical companies and other organizations may borrow copies of these translations through the facilities of The Paul Kollsman Library upon application by the company librarian. Because of the importance of this material, the regular library loan period has been extended to two weeks, in order that these translations may be utilized to their full advantage. Requests should be made by number, author, and title on the regular Library book request cards. Because of the many requests for these translations, no more than five copies may be borrowed at one time by one organization.

The translations have been reproduced from typewritten copy, and the number of pages in each is indicated at the end of each reference. Bibliographic information has been taken directly from the translations. Photostatic copies are also available at the usual library rates.

2093 Roth, J. F. *The explosive properties of tetranitromethane-nitrobenzene mixtures; a contribution to the hydrodynamic theory of detonation.* Zeitschrift für das gesamte schiess- und sprengstoffwesen, v. 36, nos. 1–3, January–March, 1941, p. 4–6, 28–30, 52–55. 15 p.

2094 Grosskopf, J., and Vogt, K. *Measurement of ground conductivity.* Telegraphen-fernsprech- funk- und fernsehtechnik, v. 29, no. 6, 1940, p. 164–172. 15 p.

2095 *Simple device for the rapid removal of burrs in the flared end sections of light alloy pipes (Junkers).* Der Flieger, v. 22, no. 10, October, 1943, p. 308. 2 p.

2097 Mangler, W. *Two remarks on the Schwarz-Christoffel transformation.* Zeitschrift für angewandte mathematik und mechanik, v. 18, no. 4, August, 1938, p. 251–252. 4 p.

2098 Förster, F., and Stambke, K. *Magnetic investigation of internal stresses. Part 1. Internal stresses in stretching nickel wire.* Zeitschrift für metallkunde, v. 33, no. 3, March, 1941, p. 97–104. 13 p.

2099 Förster, F., and Stambke, K. *Magnetic investigation of internal stresses. Part 2. Internal stresses in die-drawn nickel wires.* Zeitschrift für metallkunde, v. 33, no. 3, March, 1941, p. 104–114. 17 p.

2101 Tommasi, A. *Concerning the measurement of small time intervals.* Alta frequenza, v. 10, no. 6, June, 1941, p. 358. 1 p.

2102 Oschatz, H. *Methods for balancing airscrews.* Luftwissen, v. 10, no. 3, March, 1943, p. 69–73. 9 p.

(*Continued on page 201*)

THAT OUR COUNTRY MIGHT *Out-Devise* THE ENEMY

Small example of a BIG PROGRAM inaugurated at the outset of war

By developing an ammunition box of phenolic cloth laminate to replace one of stainless steel, Curtiss engineers simultaneously accomplished a saving of critical metal, economy of weight and a reduction in cost. Three important advantages accruing from the change of a single part!

When the war started, Curtiss-Wright instituted its own program of strategic material savings. Today many of the then critical materials are no longer on the list, but the program has been broadened to include the whole field of material research.

Lighter, stronger materials have been developed and many more are on the horizon. Not only will they increase the speed and effectiveness of our fighting aircraft but, in days to come, will make possible greater payloads for the Curtiss Transports that will fly the skies of Peace. Curtiss-Wright Corporation, Airplane Division, Buffalo, Columbus, St. Louis, Louisville.

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Curtiss-Wright

Toward Winning This War

Member, Aircraft War Production Council, East Coast, Inc.

GI's ... by proxy

Whether it's forty degrees below zero in Alaska or one hundred and seventy in the sun at Iran, the technical representatives of Bell Aircraft's field service staff help keep thousands of Airacobras flying... and fighting in the far corners of the world.

The first technical mission sent to Russia by an American manufacturer consisted of Bell Aircraft servicemen and engineers. These men gave valuable technical information to the Red Air Force to assist their engineering officers and ground crews in servicing and maintaining the thousands of Bell fighter planes on the Eastern front. In return they brought back first hand knowledge of Airacobras in action which has aided us in producing even more effective air weapons.

Theirs is a dangerous life. They are civilian G I's who play an important part in helping the Army Air Forces and our Allies to keep 'em flying. Here in America, they serve nine commands of the Army Air Forces—living a soldier's life on the California desert or in the swamps of Florida—in order to learn how to work under actual war conditions.

Some of these Bell Servicemen are now studying the new powerful fighter plane coming from our Niagara Frontier Division. Some are giving their entire attention to the flexible machine gun mounts made by the Bell Ordnance Division. Others are taking a special course on America's first jet propelled plane designed and built by Bell Aircraft —as spectacular in its way as the B-29 Super-fortresses of which Bell Aircraft is one of the producers in its bomber plant at Marietta, Ga.

And when the new Bell helicopter becomes available for general use, the service department will add this latest Bell Aircraft development to its activities. © Bell Aircraft Corporation.

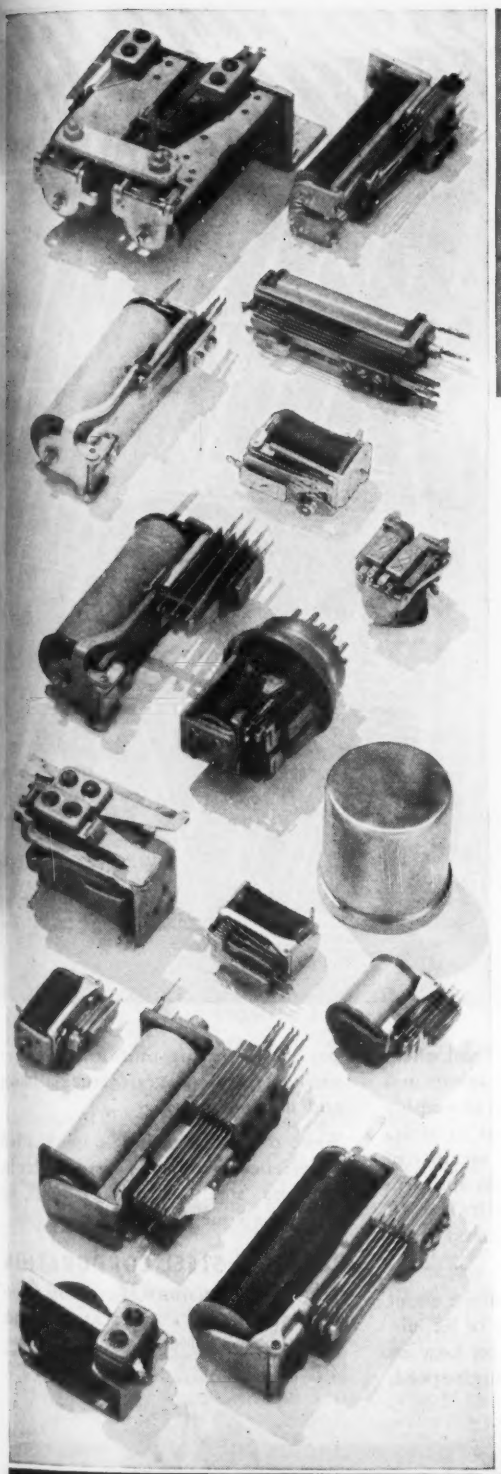
MEMBER AIRCRAFT WAR PRODUCTION COUNCIL—EAST COAST INC.

BELL *Aircraft*

PACEMAKER OF AVIATION PROGRESS

Niagara Frontier Division, Buffalo and Niagara Falls, N. Y.—Ordnance Division, Burlington, Vt.—Georgia Division, Marietta, Ga.

BUY WAR BONDS AND SPEED VICTORY



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The *right* relay, of course, is the one which will exactly fit your needs, and give you the longest, most dependable service at lowest cost. Here's how you can get it:

1. Write for the Automatic Electric catalog. It lists over forty basic types of relays, providing every combination needed for modern electrical control. All technical facts are clearly tabulated for your guidance.

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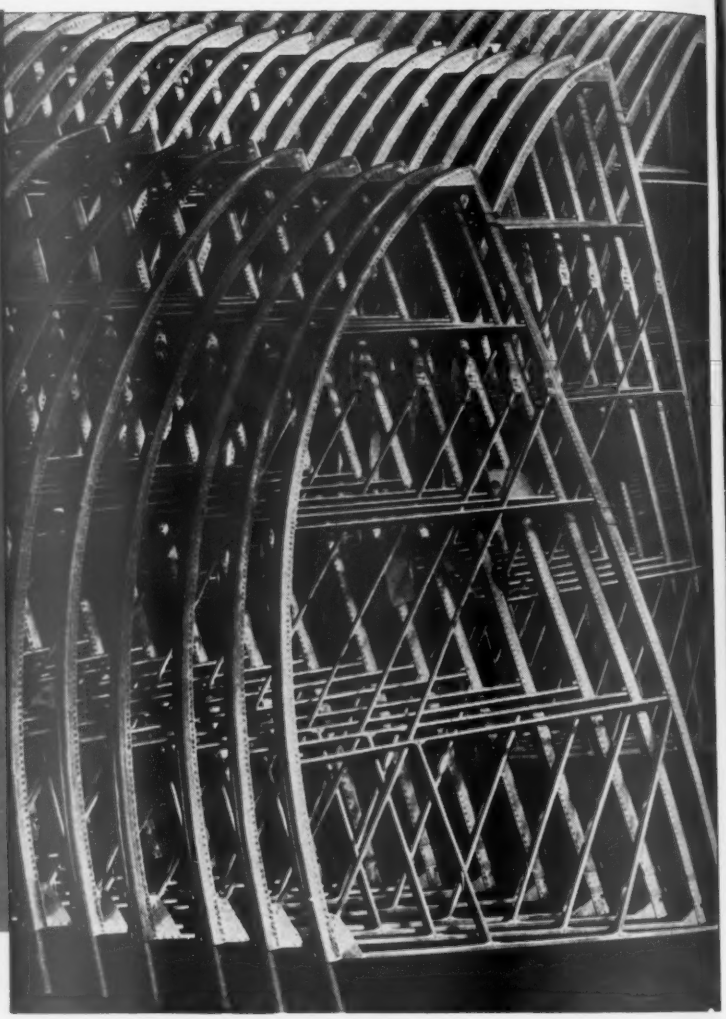
Enduro

LIGHTENS STRUCTURAL ASSEMBLIES WITHOUT SACRIFICE OF STRENGTH OR SAFETY



Wherever light weight, high physical strength and high corrosion-resistance are the all-important factors in design and performance of structural members, the answer probably is Republic ENDURO Stainless Steel.

In 18-8-HT analysis, this high strength-to-weight-ratio metal can be produced with a tensile strength in excess of 185,000 p.s.i., and with good yield point and ductility.

Republic ENDURO is highly resistant to rust and corrosion—hence does not require extra thickness to insure against weakening due to loss of metal caused by corrosion. And no protective coating is necessary.

Another important feature of ENDURO is its resistance to heat and cold. It possesses high creep strength—also resists embrittlement at sub-zero temperatures.

Because of this combination of qualities, ENDURO Stainless Steel offers unusual possibilities to designers and engineers who would like to employ smaller or lighter sections in structural assemblies—without sacrifice of strength or safety. And its uniform workability and weldability by all modern methods recommend it to production engineers.

Would you like to know more about the structural possibilities of Republic ENDURO—for instance, how its application can improve high-speed, pay load-carrying mobile equipment such as trains, aircraft, trucks, buses and marine craft?

Write us, and Republic's unequalled experience as a pioneer and leader in stainless steel production will be placed at your disposal.

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Export Department: Chrysler Bldg., New York 17, N. Y.

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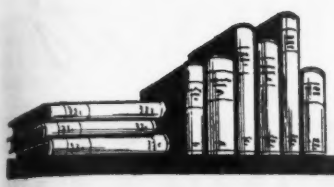
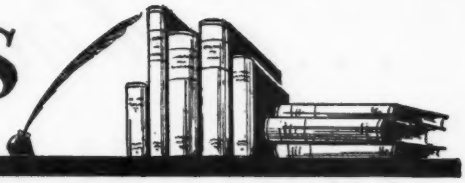
Other Republic Products include Carbon and Alloy Steels—Pipe, Sheets, Strip, Plates, Bars, Wire, Pig Iron, Bolts and Nuts, Tubing



BOOKS



AAF, the Official Guide to the Army Air Forces; A Directory, Almanac and Chronicle of Achievement

Contents: What We Are; Who We Are; How We Train; What We Fight With; How We Keep 'Em Flying; What We Fight From; Our Battlefield; Our Air Forces in Action; Historical Highlights; Awards and Insignia; Rotogravure Sections.

No book that has been published has given such a complete description of the work of the Army Air Forces as this guide. Prepared with the approval of General Arnold and copyrighted by the Army Air Forces Aid Society, it will become the standard reference book on American air power. It is published in two forms; the paper edition sells at $0.25 and the bound book at $2.50.

The book endeavors to give the public a detailed description of the organization, operation, and personnel of this comparatively new military force. It gives an outline of the training program, tells how the maintenance work is done, and describes the combat forces in action. To this is added a chronology, a bibliography, and a glossary. Simon and Schuster, New York, 1944; 380 pages, $2.50. Pocket Books, Inc., New York, 1944; 380 pages, $0.25.

Safety After Solo: How to Fly 10,000 Hours

Lt. Comdr. John R. Hoyt

Contents: The Right Mental Attitude; Recognizing Weather: Thunderstorms, Fog, Icing; Compass Courses; What to Do in a Forced Landing; Planning and Making a Cross-country Flight; Sharpening the Senses; What Every Pilot Should Know about Turns; How to Check Your Plane; How to Fly Sixty Minutes an Hour; Five Difficult Maneuvers Made Easy; Good Morning, Inspector!; How to Use the Eyes at Night; Night Flying; Avoiding Dizziness in Turns; If You're a New Instructor; How High Can You Fly?; The Best Pilots Become Scared; How to Get 10,000 Hours.

This is one of the most interesting presentations of flight instruction, because of the method of approach. It will be read with equal interest by the student pilot and by the pilot with many hundreds of hours in the air.

As an inspector of the C.A.A., the author has learned what caused accidents and shows how many of them could have been avoided. He indicates the danger periods in the history of every pilot and tells of experiences that demonstrated how pilots can keep themselves up to the standards required by the C.A.A. He emphasizes the need for the right mental attitude to avoid the danger elements of a pilot's career. The use of the eyes at night and the special requirements of night flying are given special attention.

The purpose of the book is to guide a pilot to the formation of habits that will enable him to get 10,000 hours of flying time. McGraw-Hill Book Company, Inc., New York, 1944; 356 pages, $3.00.

With the exception of aeronautical annuals and books published outside the United States, books reviewed in this section may be borrowed without charge from The Paul Kollsman Library of the Institute of the Aeronautical Sciences, 1505 RCA Building West, 30 Rockefeller Plaza, New York 20, N. Y.

The Aircraft Year Book for 1944

Howard Mingos, *Editor*

Contents: The War in the Air; The American Record; The U. S. Army Air Forces; U. S. Naval Aviation at War; The Civil Air Patrol; Air Transport in the War; Aviation Training for War; Work of the Federal Bureaus; Aeronautical Organizations; New Things in the Air; Aircraft Designs; Flying Facts and Figures.

For 26 years this annual has recorded the progress of American aeronautics. Its authority has never been questioned and therefore it has become an indispensable book of reference for those who wish to keep informed regarding the work of the American aircraft industry.

No one will read of the great success of the many component parts of this industry, which is the industrial marvel of the present time, without a feeling of satisfaction. Justifiable pride may be felt for the accomplishments of that small group of persevering aircraft designers who carried on when the going was hard and who are now showing that they can make the best airplanes in the world.

The Year Book records the war in the air, the military and naval developments, the great expansion of air transport, the aviation-training programs, and the work of aeronautical organizations.

A directory and statistical information round out the completeness of the book. Lanciar Publishers, Inc., New York, 1944; 727 pages, $6.00.

Modern Operational Mathematics in Engineering

Ruel V. Churchill

Contents: The Laplace Transformation; Further Properties of the Transformation; Elementary Applications; Problems in Partial Differential Equations; Functions of a Complex Variable; The Inversion Integral; Problems in Heat Conduction; Problems in Mechanical Vibrations; Sturm-Liouville Systems; Fourier Transforms.

Methods of solving applied problems in partial differential equations are presented in a textbook for engineers and physicists. The two principal topics treated are partial differential equations of engineering and Laplace transforms. Also included are problems in ordinary differential equations, as well as other types of problems. The operational properties of the Laplace transformation are derived and illustrated. These are used to solve problems in vibrations and resonance in mechanical systems, with some attention to electrical analogues of these problems. Problems in the conduction of heat, electrostatic potential, and other problems are treated by this method or related methods. McGraw-Hill Book Company, Inc., New York, 1944; 306 pages, $3.50.

Air Power and the Expanding Community

Major Oliver Stewart

As a participant in many phases of the growth of aviation for 30 years, Major Stewart, who is one of the best-informed writers on aeronautics, offers a book that challenges many current ideas.

He believes that air power should be integrated with military and naval forces and should not have further independent development. He emphasizes the tactical employment and minimizes the strategic advantages of a separate force. He concludes that the man on the ground will always take the final objective.

Although it is brilliantly written by one who can turn any evidence to fit his own thesis, there will be many who will prefer to await the reports received as to the results of independent action of

. . . *and in* SYNTHETICS *it's* GENERAL *for* TOP-QUALITY!

WHAT HAPPENS AFTER REPEATED LANDINGS?

. . . to the beads, the tread, the cords? General 56″ synthetic-nylon, static conductor, smooth contour tire, here is shown mounted on a huge dynamometer. Any potential weaknesses arising from rolling and braking loads are discovered as the mounted tire is "landed" —again and again—on the flywheel whose surface speed approximates aircraft landing speeds. Today's synthetic-nylon General passed the test for *extreme landing speeds* with flying colors . . . just as it passed many similar rigid laboratory tests covering every phase of service conditions.

General Synthetic-Nylon Aircraft Tires Meet and Better General's Rigid Performance Standards!

Tested in conjunction with the Army Air Forces, General's special compound of synthetic rubber has proved its excellent wearing qualities, in rigid service tests as well as rigid laboratory tests.

Thus, in synthetic-nylon aircraft tires—as with former construction, General Tire has demonstrated its ability to engineer and produce a tire that delivers the *extra quality* for which Generals have always been known.

Regardless of new materials or service requirements, you can depend on this: General Tire will continue to set the standard for *Top-Quality* in airplane tire design.

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General's synthetic construction is available with nylon or rayon for tail-wheel tires as well as main landing gear tires.

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the R.A.F. and the A.A.F. before they accept conclusions based on the successful African campaign where ground and air forces achieved such an outstanding victory by joint effort.

The author praises Gen. William Mitchell's conception of a "Department of National Defense" with subdivisions for the Army, Navy, and Air. It is not unlike the recent proposals made by the War Department for a postwar reorganization of our services.

Just as war has been changed by aviation, it is the author's belief that, through air transport, nations will expand into commonwealths and communities will enlarge their boundaries of influence.

Whether or not the reader accepts all the conclusions of Major Stewart, he will find the book provocative of serious thinking about present and postwar problems. George Newnes Limited, London, 1944; 232 pages, 15*s*.

Air Navigation Made Easy

James Naidich, with the Editorial Assistance of Harry Schor

Contents: Maps, Aeronautical Charts, and Air Piloting; The Aircraft Compass; The Wind Triangle; Locating Position in Flight; Radius of Action and Federal Aids to Navigation.

Written to provide the fundamentals in air navigation needed by private civilian pilots, this book sets forth the basic principles of air piloting and dead reckoning. It does not extend into the fields of radio navigation and celestial navigation, since these methods are not ordinarily used by private fliers. It explains how to read maps, to fly by landmarks, and to measure direction. The use of the compass is described and the reader is told how to correct for wind, to plan a trip, and to locate position in flight. The answers to problems are given in the closing pages of the book. McGraw-Hill Book Company, Inc., New York, 1944; 124 pages, $1.75.

U. S. Aviation in Wartime

Reported by the Office of War Information

Contents: Combat Performance in 1942; Combat Performance in 1943; Army, Navy Air Transport; Army Air Service Command; Naval Air Transport Service; Army Air Forces Accidents; The Civilian Air Patrol; The Commercial Airlines; The Public Airways; Post-War Probabilities.

This book presents the Office of War Information's account of the achievement and progress of American aviation in World War II. There will be some disagreement as to the evaluation by specialists in the O.W.I. of types of American airplanes. Naturally, the latest developments of some types are hidden behind the veil of military secrecy and cannot be revealed.

As a general report on the work of the Air Forces of the United States since 1941 it is an excellent handbook. The combat performances of American and foreign aircraft up to the end of 1943 are outlined with definite statements as to their utility. The Air Service Command is given full credit for its outstanding accomplishments of supply and maintenance. The Air Transport Services of the Army and the Navy and the Civil Air Patrol each have a chapter fully describing these remarkable war developments.

As a book of reference about the United States' part in the war it will be found to be useful and to give authentic information. American Council on Public Affairs, Washington, 1944; 203 pages, $2.50.

Mathematics for Aircraft Engine Mechanics

Harold Griffiths

Contents: Sharpening the Tools for Thinking; Functioning of the Engine; Engine Repair; Valve and Ignition Timing; Engine Accessories.

A manual on the theory and repair of aircraft engines, written for those who are making final preparation for Civil Aeronautics Administration examinations. The subject is taught through the use of practical problems based on actual data. The work is arranged in "jobs," beginning with a brief explanation and followed by a worked-out example and problems organized so that many questions that ordinarily arise are answered through the problems themselves. To give the student a knowledge of the vocabulary involved, trade expressions are worked into the problems. The student is also introduced to the practical use and understanding of measuring instruments as they are employed in the repair of aircraft engines. McGraw-Hill Book Company, Inc., New York, 1944; 367 pages, $2.50.

The Luftwaffe

C. G. Grey

Contents: The Start of German Aviation; The German Air Force in the War 1914–18; Germany Between the Wars; The Coming of the Luftwaffe; The Luftwaffe at War.

No one outside of Germany could have written such an interesting history of the development of the German air force. Mr. Grey visited Germany often and, as a writer with keen powers of observation, wrote his impressions for *The Aeroplane*. Having made many friends among the influential Germans, he was in a position to secure first-hand knowledge.

In this book he reviews much that he wrote about the beginning of aeronautics in Germany and shows that the Luftwaffe is not, as generally believed, the product of the Nazi party but was organized secretly long before Hitler came to power. The way the German aircraft factories and scientific laboratories were shown to visitors was surprising. When these visitors returned home and told what they saw there was much unbelief.

The side lights in Mr. Grey's books are always interesting, because he has the habit of saying what he believes even though it has a sting.

To get better acquainted with the enemy's production of aircraft, the organization of the Luftwaffe, and the men who run it, this book will be read with profit. Faber and Faber Ltd., London, 1944; 251 pages, 8*s*. 6*d*.

Aircraft Analytic Geometry Applied to Engineering, Lofting, and Tooling

J. J. Apalategui and L. J. Adams

Contents: Trigonometry; Plane Analytic Geometry; Cartesian Coordinates; True Lengths and True Angles; Equations of Planes; Equations of Lines; Translation and Rotation of Axes; Applications; Conic Sections, Graphical Treatment; Conics, Analytical Theory.

A book dealing with the application of the methods of plane, solid, and analytic geometry to the solution of a certain class of problems that arise in the design, lofting, tooling, and engineering of aircraft. It is based on notes by J. J. Apalategui used in a class in aircraft analytic geometry conducted in a Douglas Aircraft Company plant. A section of the book is devoted to conic sections as used in design and lofting. The approach is systematic and is based on the principles of plane and solid analytic geometry. McGraw-Hill Book Company, Inc., New York, 1944; 285 pages, $3.00.

The Flight Mechanic's Handbook

Group Capt. G. W. Williamson

Contents: The Flight Mechanic's Duties; The Routine of Maintenance; Books, Forms, and Records; Refuelling and Topping Up; Coolants, Engine Oils, and Lubricants; Engines and Propellers; Engine Instruments, and Controls for Engine and Propeller; Cockpit and Control Systems; Fuel and Oil Systems; Hydraulics; Landing Gear, Wheels and Brakes; Aircraft Electrical Equipment; Care of Airframe; Engine Starting and Taxi-ing; The Routine of Flying; Care and Maintenance of Ground Equipment; Inspection.

This introduction to the maintenance, handling, and care of aircraft in service opens with a chapter giving an outline of the duties of the flight mechanic. Succeeding chapters deal with these duties in detail, explaining the reasons for and operations of the various components and accessories that make up the modern aircraft. The routine of airplane maintenance and the keeping of the necessary maintenance, technical, and transfer records are given. The book is an outline of the work upon which the flight mechanic will first be employed under instruction. It de-

This is the thirteenth of a series of statements by aviation's leaders on THE SHAPE OF FLYING TO COME.

"Packaged airports are coming!"

says JOHN W. WHITE, *President of the Westinghouse Electric International Company*

"FOR AIR TRANSPORTATION *to reach its full growth, a lot of new airports will have to be established, many in remote regions.*

"To meet this need, engineers have developed pre-fabricated units of airport equipment which are packaged to be shipped by air, if necessary—and are already sub-assembled so they're ready for final assemblage at any point on the globe.

"Irrespective of location or importance, every airport needs a minimum of equipment ranging from radio communications to hangar facilities. Pre-fabricated units of this equipment can be ordered in so many combinations that almost any type of landing and service facilities can be set up.

"With their advantages of speed . . . standardization . . . flexibility . . . facilitation of shipments . . . simplicity of field erection and maintenance . . . and lowered costs, these units may well help to achieve for international aviation what America's great road projects did for the automobile!"

AND WELL THEY *may*, Mr. White—but only when the *idea* of packaged airports has successfully been *sold!*

And the first place to sell it is to the "test-pilot market"—the people who (in business or in private living) are habitually first to accept any change for the better.

This is the market aviation thinks of when it thinks of the more than a million TIME-reading families—whose incomes are twice that of the average family—who are themselves America's best prospects for plane and air travel—whose influence and positions in business make them the vanguard for any programs aviation may set up.

Believing that the ideas of aviation's leaders are always of interest to the aviation industry, TIME here gives them wider circulation in the name of

AVIATION'S SILENT PARTNERS — TIME — THE READERS OF TIME

scribes all the essential parts and services of a modern aircraft without entering into a detailed exposition. George Newnes Limited, London, 1944; 164 pages, 12*s*. 6*d*.

Aviation Gasoline Manufacture

Matthew Van Winkle

Contents: History and Development of Aviation Fuel; Development of Aviation Fuel, 1930 to 1942; Specifications and Test Methods on Aviation Fuels; Hydrocarbons in Aviation Fuel and in Aviation-Fuel Manufacture; The Production of Aviation-Fuel Base Stocks; Manufacture of High-Anti-knock Hydrocarbons; Production of Finished Aviation Gasolines; Special Aviation Fuels and Aviation-Fuel Components; Performance of Aviation Gasolines; Test Methods for Evaluation of Aviation Fuels.

Available information concerning the manufacture of aviation gasoline is summarized in this book. The author's purpose has been to present the material in such a form that it will serve as a reference for those interested in this field of refining, and to develop a fundamental discussion of aviation-gasoline manufacture that will serve as a textbook for students and others unfamiliar, or only partly familiar, with the subject.

It is noted that detailed information concerning many of the processes described in the book cannot be published at the present time. There are at least five new processes, or new modifications of older processes, that have been announced but cannot be described in detail. Similar information relating to the latest specifications and methods of test is in the restricted classification until the end of the war. However, the book is offered as a summary of existing publishable information about aviation gasoline.

This is one of the books of the Mineral Industries Series of The Pennsylvania State College. McGraw-Hill Book Company, Inc., New York, 1944; 275 pages, $3.00.

Aircraft Mechanics Handbook

Paul Van Winkle, *Editor*

Contents: Aluminum and Its Alloys; Riveting; Bending Data; AN Parts; Special Aircraft Fasteners; Aircraft Nomenclature; Simplified Mathematics; Aircraft Drafting Terms and Symbols; Aircraft Welding; Basic Metalwork; Steels; Aircraft Woodwork; Aircraft Cable and Splicing; Transparent Plastics; Aircraft Fabric Work; Protective Coatings for Aircraft.

The purpose of this book is to provide in a single pocket-size volume a technical reference guide for aviation ground crews, production mechanics, engineers, and others associated with the repair and manufacture of aircraft. It contains specifications of aircraft materials, technical data, and information concerning replacement and identification of parts and repair of aircraft structural surfaces and accessories. Army-Navy specifications and data from the manufacturers of aircraft parts and accessories are included. The Manual Arts Press, Peoria, Ill., 1944; $2.75.

Mathematical and Physical Principles of Engineering Analysis

Walter C. Johnson

Contents: The Analysis of Engineering Problems; Some Basic Physical Principles; Transient and Steady-State Conditions; Setting Up Equations; Graphical and Numerical Solution of Differential Equations; Ordinary Differential Equations; Vector Representation of Sinusoids; The Checking of Equations; Dimensional Analysis, Fourier Series; Systems with Distributed Constants.

This book was written for the primary purpose of presenting the essential physical and mathematical principles and methods of attack that underlie the analysis of many practical engineering problems. Emphasis is placed on basic physical reasoning and principles. Particular attention is given to methods of attack, the use of assumptions, procedures in setting up equations, the use of mathematics in quantitative reasoning, and the physical interpretation of mathematical results. The book is intended to supplement existing courses in mathematics rather than to supplant them. McGraw-Hill Book Company, Inc., New York, 1944; 346 pages, $3.00.

Book Notes

The Navy's War, by Fletcher Pratt; Harper & Brothers, New York, 1944; 295 pages, $2.75.

Any history written now of the U.S. Navy's participation in this war will necessarily be only that of the early part —of the period when the Navy was at its lowest point in equipment and of the time when air power had gained its new position in warfare.

The author, who is well known as a writer on naval affairs, does not write as a professional historian. He prefers to give the moods of the men in battle, to tell what they thought about and talked about, and in this way to throw it into its proper relation to what they did. He does not attempt to chronicle the events in competition with the newspapers and current magazines, but reports the war as if it were long-past history.

The book covers the period from the attack on Pearl Harbor to the campaign in the Solomons. It is a graphic account of the great battles in which the U.S. Navy turned from defense to attack in the war.

Sky Ride, by Katherine Pollock; Charles Scribner's Sons, New York, 1944; 151 pages, $1.75.

A book for boys, written to stimulate their interest in aviation. Two boys follow the usual routine of those youngsters who go to airports in the hope that some day they may become pilots.

Captain Eddie Rickenbacker; God Still Answers Prayer, by Lind Swarthout; Zondervan Publishing House, Grand Rapids, Mich., 1944; 116 pages, $1.25.

This book can almost be called a biography written in the style of a religious tract. Almost every act of its subject is treated as though it had some significance from the standpoint of religion. The miraculous escapes of the gallant captain are attributed to his belief in the efficacy of prayer. The story of the leading ace of the last war aims to be a convincing document showing that God still answers prayer.

The British Navy's Air Arm, by Owen Rutter; Infantry Journal, Penguin Books, Washington, 1944; 248 pages, $0.25.

The history and activities of this comparatively new British air service are given in great detail in this book. British naval aviation has been overshadowed by the R.A.F., but in this book it will become evident that the British navy has at last awakened to the essential role of the airplane in connection with naval action. The training of pilots, the place of the aircraft carrier as a part of the fleet, the use of airplanes for reconnaissance and spotting, the role of escorting convoys, and the combat work of naval aviation are fully described.

The illustrations add to the text and both combine to give a well-rounded picture of British naval aviation.

Look at the World, the Fortune Atlas for World Strategy, by Richard Edes Harrison; Alfred A. Knopf, New York, 1944; 67 pages, $3.50.

This atlas, which contains maps prepared by the cartographer of the magazine *Fortune*, Richard Edes Harrison, is the product of research, invention, and rediscovery. The maps are global in the sense of having the appearance of being viewed as part of a sphere. They are for use in an age of air transport. They minimize the distortions that are found on the old-fashioned maps.

Military and political strategy as well as world trade routes are dealt with, but the main purpose is not to locate battle lines and supply routes. It is more to emphasize world strategy that the maps are presented in their new form. Text matter, prepared by the editors of *Fortune*, explains the purpose of the maps and the geographic, political, and economic aspects of the different

How long between "Majors"...?

AN AIRLINES' PROBLEM... To find an aviation oil that could improve engine condition and make possible an increase in engine operating time between overhauls.

THE FLIGHT-TESTED ANSWER... Esso Aviation Engine Oil, which has proved out as follows:

Typical 600-hour Flight Test—Comparison between a widely used Aviation Oil and Esso Oil
Piston Ring Deposits
15% LESS
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28% LESS
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And In Another Flight Test...54 Top Piston Rings Were Stuck with a Widely Used Aviation Oil!
BUT NONE WITH ESSO OIL

THE POINT IS THIS... *You who know the story of aviation fuels and lubricants are familiar with how much Esso Research has accomplished. You know, too, what a very large share of the total production of aviation petroleum products comes from our facilities. Our research continues . . . our experience increases. No matter what the future aviation developments may be, we aim not only to meet your needs, but to anticipate them.*

parts of the world that are portrayed.

The entire surface of the globe is shown by sectional, spherical-type colored maps with the physical characteristics of the land and sea areas indicated. It will be a useful atlas for the study of the new geography for those who think in terms of air transport of the future.

Ordeal by Battle, by Cyril Falls; Oxford University Press, New York, 1943; 186 pages, $1.75.

The military editor of *The London Times* surveys the elements of strategy, tactics, and logistics by which man has waged warfare since the Stone Age. He discusses the five principles of warfare: concentration, protection, surprise, reconnaissance, and thrust.

The chapter on War in the Air analyzes the strategy and tactics of air power as it has been developed thus far in this war. The policy of Great Britain before the summer of 1942 is criticized as transgressing the rules of strategy by devoting too much attention to fighting and bombing aircraft and not enough to the tactical support of the Army and the Navy.

The book brings the fundamental principles into the perspective of modern warfare and will be welcomed as giving a broad view of the problems facing the leaders of the fighting forces.

Ken's Mercy Flight to Australia, by Basil Miller; Zondervan Publishing House, Grand Rapids, Mich., 1944; 64 pages, $0.60.

The story of a flight to Australia to deliver penicillin introduces all the dramatic incidents of an ocean crash, life on a rubber raft, rescue, and the final delivery of the curative to the Army in Australia.

Interspersed throughout the book are religious observations with regard to prayer and the protecting power of the Almighty as one of the principal elements of the life of airmen.

G- For Genevieve, by Lt. J. M. Herbert; Roy Publishers, New York, 1944; 254 pages, $2.50.

A Polish flier relates his and his compatriots' experiences—the bombing of their native land, their escape through Roumania, and eventually their service with the Royal Air Force. It is a vivid story of the gallant Polish pilots who have revenge in their hearts and determination in their minds.

Island in the Sky, by Ernest K. Gann; The Viking Press, New York, 1944; 181 pages, $2.50.

Although in the form of a novel, the story breathes reality. Around the forced landing of Dooley, a civilian pilot of 20 years' experience, in the northern wilds of eastern Canada, and the rescue of his party, is woven a human-interest story of the lives, tempers, and friendships of many fliers who take part in the rescue.

The book gives a realistic picture of the mental attitude of pilots, of their loyalty to their comrades when they are in trouble.

Flight Above Cloud, by John Pudney; Harper & Brothers, New York, 1944; 54 pages, $2.00.

The writer of this book of verses refers to them as songs and states that they were "not written in tranquility but in odd places and corners never far from the sound of aircraft engines." The poems provide an objective commentary upon the day-to-day life of the R.A.F.

In the poem "To American Airmen" is the following:

"American Joe, easy with civilization,
From your resounding country, from the homes
With less fear, with the loudspeaker of opportunity
And the timeless hopefulness of Uncle Sam."

Manual of Firemanship: A Survey of the Science of Firefighting, Part 2, prepared by the Home Office (Fire Service Department); published by His Majesty's Stationery Office, London, 1944; 186 pages, 2*s.* 6*d.* (net $0.75).

Part 2 of a series of manuals concerning the principles of fire fighting and the equipment used relates to the appliances employed. It gives detailed descriptions of the mechanical devices, such as pumps and primers, fire escapes and carrying appliances, ladders, and other special appliances and devices. It also includes information about the construction and operation of pumps. Tables contain instructions for routine methods of inspection and maintenance of fire-fighting apparatus. Illustrations of typical British fire-fighting equipment are included.

Aircraft Hydraulics Simplified, by David Vine; George Newnes Limited, London, 1943; 48 pages, 3*s.* 6*d.*

A guide to the fundamental principles common to all hydraulic systems for aircraft, written especially for pilots, ground engineers, and students of aeronautical engineering. After an introductory survey of first principles, the author discusses hydraulic systems and their component parts. Sections deal with primary units, secondary units, and piping. A description is given of the emergency and safety devices, together with their operation and maintenance.

Aeronautics Recognition Guide to Operational Warplanes, edited by Lt. (j.g.) L. C. Guthman; National Aeronautics Council, Inc., New York, 1944; 178 pages, $0.50.

The seventh and eighth editions of a quarterly book giving information to aid in the recognition of aircraft have been combined into a single volume. The introductory pages contain a discussion of the fundamentals of aircraft recognition, based on the shape of wings and tail assemblies, and the form and location of engines. The systems used by the United States and other countries for the designation of military aircraft types are explained, and tables give the type designations, the assigned names, and the manufacturers of the leading military aircraft of the Allied and Axis powers.

Succeeding pages are prepared in uniform style, containing illustrations, three-view silhouettes, and specifications of the operational aircraft of each nation, grouped according to the aircraft type—such as bombers, fighters, trainers, reconnaissance airplanes, etc.

Among the new features of the current edition is a code showing the recognition characteristics of the type of aircraft described on each page. An example is the code designation for the North American Mitchell B-25 which is 2E-MB-MW, meaning a twin-engined medium bomber, of mid-wing construction. A two-line description gives a compact résumé of the important identification features. Another new feature is that the silhouettes are drawn to scale, to show the relative size of the airplane and a comparison of its size with a 100-ft. square.

A directory of aircraft manufacturers in both the Allied and Axis countries, a glossary of terms, national insignia of the various countries, and the U.S. Navy's nicknames for Japanese planes are other features of the book.

Calculus Refresher for Technical Men, by A. Albert Klaf; Whittlesey House, McGraw-Hill Book Company, Inc., New York, 1944; 431 pages, $3.00.

A "refresher" on the fundamental concepts, methods, and practical applications of simple calculus, prepared especially for technical men in industry. The basic concepts and methods of differential and integral calculus are presented by means of questions and answers.

Air Transport Operations Notebook; Air Transport, New York, 96 pages, $1.00.

This first edition of a notebook for air-transport operators consists of a compilation by the editors of *Air Transport* of significant articles on air transport that have been published in recent issues of that magazine. Specialists in the various fields write about postwar air transport, regulation, meteorology, instrumentation, maintenance, and cargo handling. It gives some provocative ideas regarding many phases of air transport.

World Maps and Globes, by Irving Fisher and O. M. Miller; Essential Books, New York, 1944; 168 pages, $2.50.

This study of maps is a book that will give the reader the rudiments of map making. It indicates the difficulties of presenting the areas of the surface of the global earth with accuracy on flat surfaces. The score or more of different kinds of maps which attempt to do this show how inaccurate have been the con-

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HEAT . . . as pliable as a piece of ribbon . . . that can be bent, twisted or folded in almost any size or shape, can be designed to fit your contact heating problem.

The H. & A. Electric Contact Heat Unit—a wartime engineering development to prevent freezing of aircraft machineguns at sub-stratosphere temperatures—is adaptable to practically any industrial situation.

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cepts of the geography taught in the schools for generations. The authors give explanations of the problems that confront the cartographer when he is making maps for different uses.

The questions and answers at the end of the book are evidently intended to emphasize the errors that have been impressed on the minds of the public through the study of the Mercator projection map.

Born in Battle, by Capt. Rowan T. Thomas; The John C. Winston Company, Philadelphia, 1944; 367 pages, $3.00.

This is a story of the 200,000 miles of flying by the 108 men of the 513th Bombardment Squadron. They flew in the Far East, the Middle East, and in the Italian campaign. The manuscript of the book was lost in Egypt, but after extraordinary adventures on the part of those in whose care it had been placed, it was recovered and brought to this country.

The book was written as a personal eye-witness account of the experiences of the men in the Squadron, and shows what dangers they encountered in the air and their hardships on the ground. As they were engaged in some of the most interesting combat action in the war, the book brings the reader into intimate contact with the life of airmen doing the work that is leading the victory.

Daybreak for Our Carrier, text by Lt. Max Miller, official U.S. Navy photographs by Lt. Charles E. Kerlee; Whittlesey House, McGraw-Hill Book Company, New York, 1944; 184 pages, $2.50.

The experiences related in this book take place on an unidentified aircraft carrier. The intention was evidently to acquaint the public with the details of life on a U.S. Navy carrier. This is done with a full understanding of the different functions of this comparatively new type of warship and of the work done by the officers and the crew.

It gives the feeling of being at sea on one of the great aircraft carriers on a task-force mission. It tells of the life of the men on duty and at play. It was written and illustrated, not by professional correspondents or assigned observers, but by Navy officers on regular duty. It is well illustrated with photographs taken aboard the carrier. The Navy Office of Public Relations, in cooperation with the Council on Books in Wartime, has made the material of this book available. All royalties resulting from its sales are directed to the Secretary of the Navy for dispersal to such Naval welfare funds as may be selected.

Navy Wings of Gold, by Florance Walton Taylor; Albert Whitman & Company, Chicago, 1944; 232 pages, $2.00.

This is a story of three young Americans who won their Navy wings by way of the Reserves. It is essentially a book describing the life and training of a Naval Aviation Cadet and takes the reader through each step in the course given which leads to the presentation of the wing insignia.

A Modern Military Dictionary, by Col. Max B. Garber and Col. P. S. Bond; P. S. Bond Publishing Company, Washington, 1942; 272 pages, $2.50.

The need for a modern and comprehensive military dictionary at a time when so many new activities are being added to the work of the soldier and the airman is obvious. New machines and weapons bring new nomenclature. The present volume is timely and will be found helpful not only to the military but to the public.

The definitions have been written so that they can be understood by the layman as well as by the expert.

The addenda giving the modern slang used in the Army and the Air Forces will also make the dictionary useful in assisting to an understanding of the odd terms that confuse so many when listening to the service man.

War Pictures by British Artists: Second Series, No. 1, Women, 64 pages, $0.50; No. 2, Production, 62 pages, $0.50; No. 3, Soldiers, 63 pages, $0.50; No. 4, Air Raids, 62 pages, $0.50; Oxford University Press, New York, 1943.

These four books contain sketches made by 18 well-known English artists. They give a vivid idea of the effects of the war on British life. Each pamphlet has an introduction describing the specialty treated by the pictures.

Their drawings show some of the damage done to the historic and religious buildings of England by German bombing, as well as the superhuman endurance of the British men and women in their war work. They will acquaint future generations with the kind of work war entails, and stimulate determination to make such devastation and human toil an impossibility in the future.

Readings on Post War Personal Aircraft, compiled by Norman Nicholson; Globe Aircraft Corporation, Fort Worth, Tex., 1944; 100 pages.

This booklet is a compilation of articles and addresses about light private airplanes and their possible markets after the war. Many points of view are expressed, all of which lead to hopeful conclusions that the use of personal aircraft will be one of the important developments of postwar aviation.

Down to Earth; Mapping for Everybody, by David Greenhood; Holiday House, New York, 1944; 262 pages, $4.00.

The author has attempted to make a confusing science interesting by writing in a style to be read rather than studied. With the aid of hundreds of illustrations, he has succeeded in making it possible for the layman to have an understanding of interpreting and applying maps.

After giving some of the fundamentals necessary for the preparation of the data from which maps are made, he includes chapters on how various types of maps are used.

The recent urge for maps that show great-circle routes more clearly is satisfied by a description of the many types, each of which has certain advantages. The amateur map maker will find instructions and suggestions which will aid him in his avocation.

The book is one of the most complete and practical that has been issued on this phase of the general subject of geography, and will be useful in acquainting the airman with one of the important tools of his trade.

Dictionary of Service Slang, compiled by Park Kendall; M. S. Mill Company, Inc., New York, 1944; 60 pages, $1.00.

It is becoming more and more difficult to understand the men of the armed forces when they use the new slang of the American services, especially when it is interspersed with slang they have acquired from overseas.

This dictionary is an excellent guide to the slang terms used by the Army, the Navy, the Marines, the Spars, the Waves, the Wacs, the nurses, and by the Australian and New Zealand soldiers. There are also some of the most-used slang words of the English Wrens and Waafs.

The humor and sarcasm of the slang will be amusing to the civilian as well as informative to the men and women in the services.

A Yankee Flier Over Berlin, by Al Avery; Grosset & Dunlap, New York, 1944; 212 pages, $0.60.

The story of two fighter pilots who saw action in the Battle of Britain and later in the South Pacific and Africa.

After that they were ordered to the Eighth Air Force and had many experiences while bombing Germany. Taken as prisoners after crashing in Germany, they made a spectacular escape through Holland.

It is another of a series of "Air Combat Stories" that describes the adventures of Army and Navy fliers.

Eisenhower: Man and Soldier, by Francis Trevelyan Miller; The John C. Winston Company, Philadelphia, 1944; 278 pages, $2.00.

Although the Commanding General of the invasion forces in Europe did not have any experience in flying, this book gives a detailed biography that shows how he rose to his present military position.

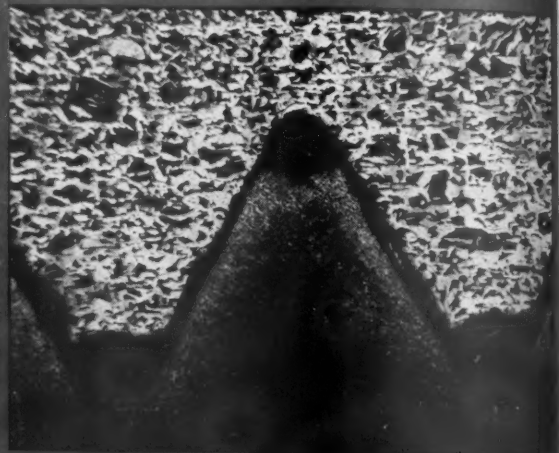
As Commander-in-Chief of the Allied forces on land, sea, and in the air, General Eisenhower directs the operations of the Air Forces. This book will be read with the greatest interest by all who wish to be acquainted with the detailed story of his life.

Pathfinders, by Cecil Lewis; William Morrow & Company, New York, 1944; 249 pages, $2.50.

This novel is different in its arrangement from the usual story of combat. It gives the life history of six men of a Royal Air Force bomber crew, who came

WHAT HAPPENS TO STEEL WHEN NUT MEETS BOLT?
Blow them up 100 times in the Metalgraph and see why some fasteners fail

This photograph shows somewhat excessive decarburization in the bolt, and a lap in the thread. Nut is satisfactory. Heat treatment O.K.



Decarburization of bolt satisfactory. Thread form good. Heat treatment slightly deficient. Nut satisfactory.

To the naked eye, nuts and bolts are just nuts and bolts. To be sure, surface defects are sometimes apparent, but they are easily detected.

What happens to the granular structure of the metal when the nut has been fastened to the bolt, and then broken in test, is something else again . . . and terribly important.

This is just one of the many precautions our metallurgists and engineers take to insure superlative performance . . . an example of the minute attention to details that makes for National Quality.

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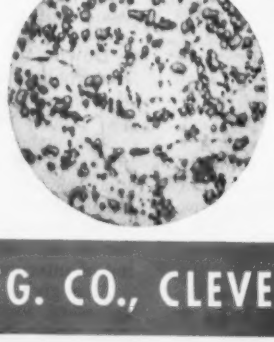
Operator checking grain structure of steel by means of the Metalgraph.

Heat-treated alloy steel, enlarged 1,000 times.



Spheroidized alloy steel wire, enlarged 750 times.

THE NATIONAL SCREW & MFG. CO., CLEVELAND 4, O.

from different parts of the world and had interesting experiences before as well as after entering service. The author's flashbacks lay the groundwork for a better understanding of how the teamwork of such a group made them so effective.

It is written by a pilot of World War I, a man who has had long flying experience. Therefore the book has a degree of accuracy and a vivid quality that make it interesting reading.

Freedom of the Air, by Keith Hutchison; Public Affairs Committee, Inc., New York, 1944; 31 pages, $0.10.

This pamphlet reviews the history of efforts made for the freedom of air passage over international boundaries since the use of balloons in the Franco-German War of 1870 posed the problem of the treatment of captured aeronauts. Subsequently the claims for complete sovereignty of the air over nations have grown to a point where the question may strangle the expansion of international air transport in the postwar era.

Summarizing, the author feels that world airways will not foster good-neighbor relations if they are monopolized by one nation or a cartel of great powers. He believes that the basic principle of reciprocal right of innocent flight granted by a representative board with wide but defined powers may result in the submerging of a small fraction of each nation's individual powers. The alternative would be the loss of the unparalleled opportunity that the future of air transport offers.

The Airplane and Tomorrow's World, by Waldemar Kaempffert; Public Affairs Committee, New York, 1943; 32 pages, $0.10.

The science editor of *The New York Times,* after writing thumbnail sketches of many of the recent advances made in aviation, discusses the postwar problems of freedom of the air. He believes that countries will have to yield some of their present ideas about sovereignty if the airplane is to become a vehicle of world air transport.

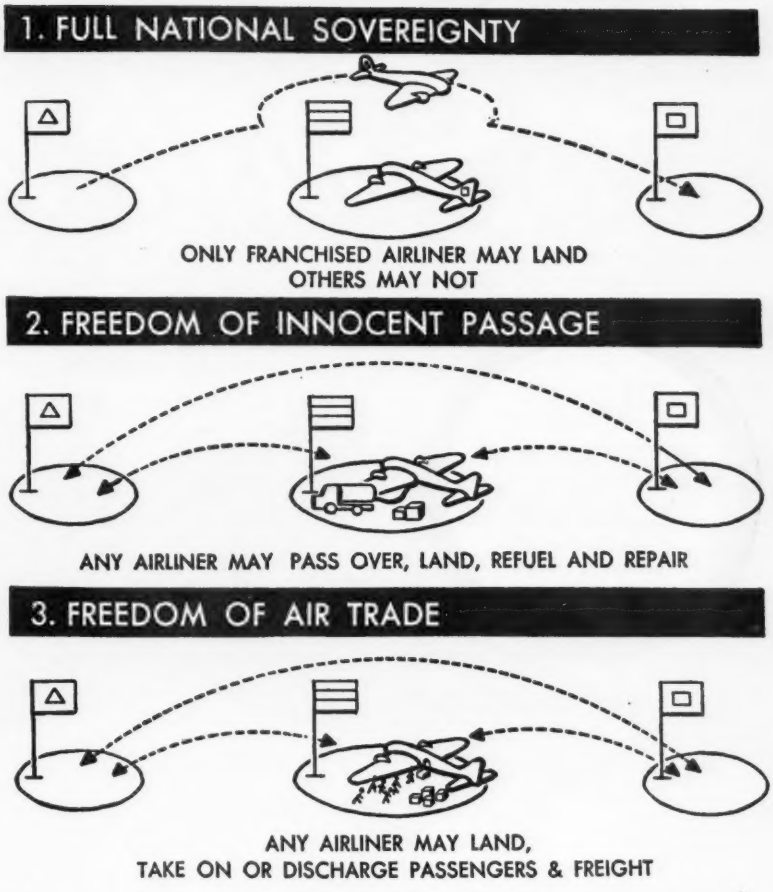
The author argues that information regarding the technical developments should be exchanged freely, even to the extent of the pooling of patents by a world administrative body.

Elementary Topography and Map Reading, by Samuel L. Greitzer; McGraw-Hill Book Company, Inc., New York, 1944; 157 pages, $1.60.

A textbook on topography and map reading, written especially for the use of high-school students. The book has been written in simple, nontechnical language, and the mathematical portion has been made as easy as possible so that students with no mathematical training can use it. Modern advances in the subject, such as the theory of contour lines, have been fully developed. Exercises are provided at the end of each chapter.

The Annals of the American Academy of Political and Social Science: Transportation: War and Postwar, edited by G. Lloyd Wilson; The American Academy of Political and Social Science, Philadelphia, 1943; 258 pages, $2.00.

The November, 1943, issue of the bimonthly publication of the American Academy of Political and Social Science is devoted to a collection of articles on war and postwar transportation. The articles are grouped under three separate sections of the book. The first is titled "Carriers and the War"; the second, "Transportation Problems of Allied Nations"; and the third, "Postwar Problems to be Faced." In addition to the more general treatment of the transportation subject as a whole, there are several articles dealing specifically with air transportation. One of these is on the air transport industries in wartime and another is on the Air Transport Command of the Army Air Forces.


1. FULL NATIONAL SOVEREIGNTY
ONLY FRANCHISED AIRLINER MAY LAND
OTHERS MAY NOT
2. FREEDOM OF INNOCENT PASSAGE
ANY AIRLINER MAY PASS OVER, LAND, REFUEL AND REPAIR
3. FREEDOM OF AIR TRADE
ANY AIRLINER MAY LAND,
TAKE ON OR DISCHARGE PASSENGERS & FREIGHT

Three suggested plans for postwar aviation. (From *Freedom of the Air,* used by courtesy of the Public Affairs Committee.)

Magnesium, Its Production and Use, by Ernest V. Pannell; Pitman Publishing Corporation, New York, 1944; 137 pages, $4.00.

This is a reprint of a text first published in 1943. Dealing with the properties, production, and applications of magnesium and magnesium alloys, it develops its subject from the engineering and industrial points of view rather than from the scientific and metallurgic aspects.

The Aviation Secretary, by Queena Hazelton; McGraw-Hill Book Company, Inc., New York, 1943; 233 pages, $1.50.

This manual contains a compilation of Gregg shorthand outlines for general aviation terms. The terminology is divided into several sections: air navigation, meteorology, aerodynamics, power plant, and radio and communications. Each group of lessons includes a technical preview, solid-matter dictation, and lists of the most commonly occurring words and phrases.

Weight Handbook, Volume I, Frank J. Meyers, editor-in-chief; Society of Aeronautical Weight Engineers, Inc., Glendale, Calif., 1944; $5.00.

The second edition of Volume I of a handbook of aeronautical engineering information has been compiled by weight engineers representing various manufacturers in the aircraft industry. It is divided into seven sections devoted to general information, the weights of raw stock, the unit weight of materials, Army-Navy Standards, Naval Aircraft Factory Standards, National Aircraft Standards, and miscellaneous manufacturers products.

South Wind

FIRST
IN EXPERIENCE

In 1942, the *first* production installation of a ram-operated combustion-type heater

IN THE FIRST DAYS OF WAR, the PBY's and their gallant crews performed the "impossible"—except when icing stopped missions the enemy couldn't halt. Heat—to keep ice from forming—could lick the problem . . . if great volumes of heat could be had without bulk and weight and heavy blowers . . .

And so South Wind delivered a "famous first"—the first production installation of hermetic combustion heaters *not engine connected, but ram-air operated* —powered simply by the movement of the plane!

As early as 1940, Stewart-Warner had demonstrated a ram-operated South Wind heater to the aircraft industry. After 15 months' development, a much improved version was successfully test-flown to an altitude of 30,000 feet. And in 1942, Stewart-Warner was able to deliver production models of ram-operated South Wind heaters for the PBY.

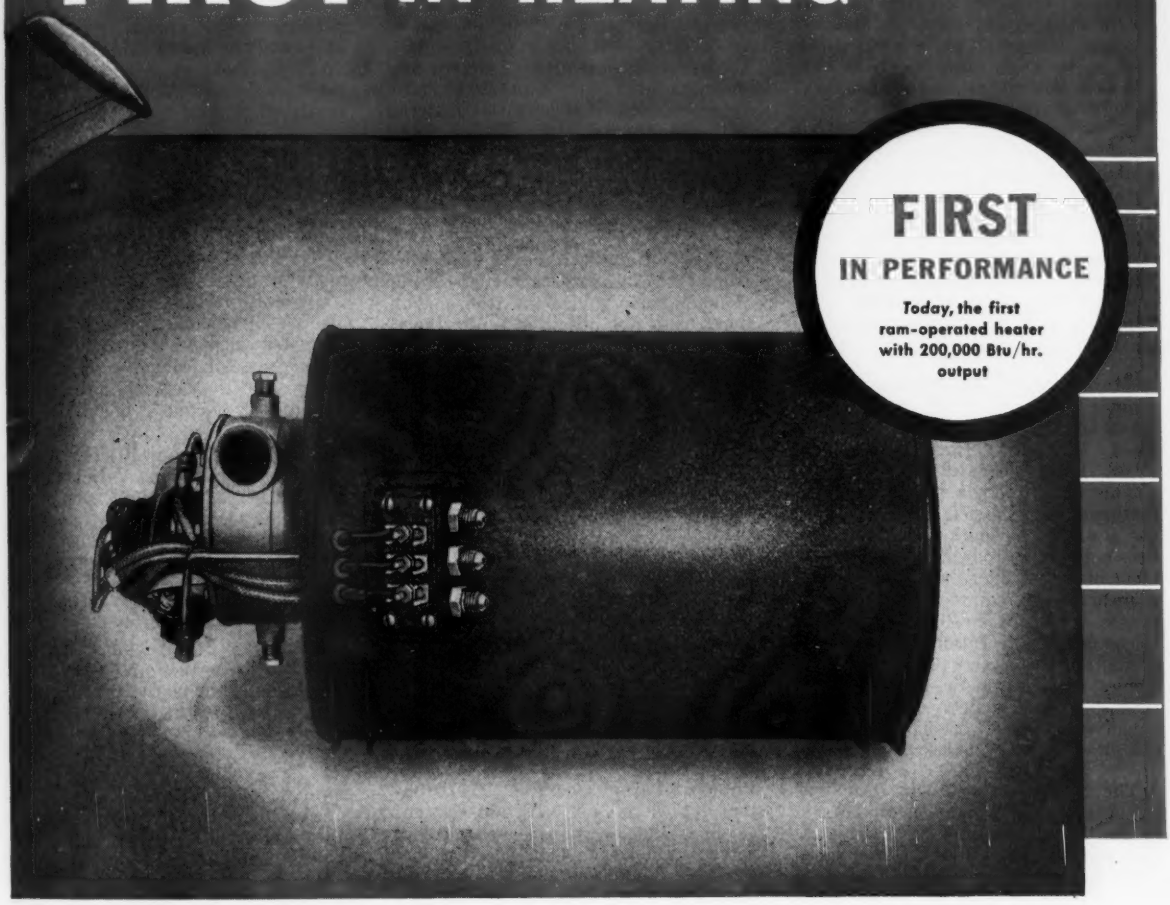
Again, a look at the record shows South Wind FIRST IN EXPERIENCE, FIRST IN PRODUCTION, FIRST IN PERFORMANCE!

Another Product of STEWART WARNER

South Wind
REG. U. S. PAT. OFF.

West Coast Office: Stewart-Warner Aircraft Heater Engineering and Service

FIRST IN HEATING



TODAY—for some of the latest and greatest heating needs in aircraft, South Wind is *in production and delivering* another "famous first"—the first hermetic-combustion heater for aircraft delivering 200,000 *dependable* Btu/hr.—and powered by ram-air, without blower or engine connection.

Its size—just over that of an ordinary waste-basket. Its weight—23 pounds. Its performance—dependable as only South Winds have proved themselves under every climate and condition of every battlefront!

And team-mate to this Model 911 South Wind is another South Wind "first"—the first Fuel Metering Control—that steps up fuel flow and *keeps the heater operating at maximum* as plane speed increases, instead of restricting air flow—*keeping heat output at minimum*—and inviting icing of a restricting device itself, with resultant failure of the whole system.

If you have a heating problem, look to South Wind. A "famous first" that licked some other tough problem may be a ready-made answer to yours.

Heating

HEATER DIVISION, STEWART-WARNER CORPORATION, CHICAGO 14, ILL.

1273 Westwood Boulevard, West Los Angeles, California

Handbook of Instructions for Salvage Repair as Standard Factory Operations, compiled from data supplied by the Engineering Committee, Aircraft War Production Council, Inc., California, 1944; 86 pages, $1.23.

The procedure for making certain standard salvage repairs to aircraft structures is described in this book. It is pointed out in the foreword that even in the field of error-repair a "standard method" may result in the smallest possible production loss. Sections deal with metal-sheet repairs and structural-member repairs.

It is intended that this handbook show only the actual procedures for making the repair, together with such detailed fabrication as may be necessary. Directly related material, such as rivet size and spacing data, also are included. A complete description of all possible causes for each damage has not been attempted since such information is regarded as belonging more properly to the techniques of manufacture.

Mathematics for Navigators, by Comdr. Delwyn Hyatt and Comdr. Bennett M. Dodson; McGraw-Hill Book Company, Inc., New York, 1944; 106 pages, $1.25.

This book offers a review of those mathematical subjects necessary for the study of navigation. Although it does not purport to be a complete treatment of any of the subjects dealt with, it includes the required material for a person who is interested primarily in the practical application to navigation of the various phases of mathematics. Topics are: arithmetic, algebra, logarithms, plane geometry, plane trigonometry, spherical trigonometry, and oblique spherical triangles.

The Supervisor's Job in Industry, by Anthony C. Baudek and Mark L. Brooks; McKnight & McKnight, Bloomington, Ill., 1944; 128 pages, $0.80.

A pocket-size guide for supervisors. Information is given about the supervisor's place in industry, maintaining a working staff, speeding production, maintaining quality, eliminating waste, and employer-employee relations.

Defence Against Dive-Bombers and Low-Flying Enemy Aircraft, by Major C. H. B. Pridham; George Allen & Unwin Ltd., London, 1942; 30 pages, 1*s.* 6*d.*

The third edition of a handbook for light machine gunners, in which the principles of antiaircraft defense against low-flying enemy aircraft are outlined. In addition to instructions for the engagement of air targets by light automatics and for aiming and controlling such guns, particulars are given concerning various types of machine guns. A chapter is included relating to some of the successes obtained by Lewis and Bren guns against enemy low-flying aircraft. These instances have been selected from reports issued from time to time by the Ministry of Information.

Fields and Waves in Modern Radio, by Simon Ramo and John R. Whinnery; John Wiley and Sons, Inc., New York, 1944; 502 pages, $5.00.

Designed for students who have had the usual engineering mathematics courses through calculus, this book deals with certain aspects of electromagnetic theory in their relation to the problems of modern radio and electronics engineering. Beginning with the discussions of oscillation and wave fundamentals, the equations of stationary electric and magnetic fields, and solutions to static field problems, it follows this material with chapters on Maxwell's equations and high-frequency potential concepts, circuit concepts and their validity at high frequency, skin effects, and circuit-impedance elements. It then goes on to offer data on propagation and reflection of electromagnetic waves, guided electromagnetic waves, characteristics of common wave guides and transmission lines, resonant cavities, and radiation.

Motores de Aviación (Aircraft Engines), by Gino di Brai; "El Ateneo," Buenos Aires, 1942; 204 pages, $2.50.

The author gives comprehensive descriptions of the functions of each of the principal parts of the engine, in terms understandable to the layman. Among the features is a detailed explanation of the combustion cycle, accompanied by diagrams made up of black-and-white blocks showing what takes place inside the engine at different points during the two revolutions of the crankshaft that constitute the complete cycle of a four-cycle engine. Diagrams of this kind show the action of in-line, V-type, W-type, and single-row and twin-row radial engines.

The chapters are titled as follows: Principal Parts; Operation; Distribution; Fuels; Ignition; Lubrication; Cooling; Starters; Fuel Consumption, Power, Efficiency, and Calculations; Practical Standards. The book is replete with useful data, and should go a long way toward assisting Spanish-speaking students and mechanics in getting authentic information concerning any type of aircraft engine.

Instructional Tests in Aeronautics, prepared by Albert J. Rosenberg, edited by Arthur S. Otis; World Book Company, Yonkers-on-Hudson, N.Y., 1944; 92 pages, $0.25.

A booklet containing 30 unit tests prepared to include the topics in a typical course in elementary aeronautics. The tests are also designed to prepare a student candidate to pass the necessary examinations for a private pilot's license. Correct answers to the questions in the test are given in a separate key. The booklet discusses in considerable detail the topics in the Civil Aeronautics Administration's private pilot's examination.

Adhesives, by Felix Braude; Chemical Publishing Company, Brooklyn, 1943; 154 pages, $3.00.

This is a book written for the practical man interested in adhesives as a producer, consumer, or salesman, rather than for those who are concerned with the scientific aspects of adhesives. The subject is presented from the practical point of view. First chapters deal with raw materials and the theory, applications, and testing of adhesives. The author then considers the different types of adhesives. Among those discussed are starch, dextrine, casein, and sodium silicate adhesives. Other chapters are concerned with animal and vegetable glues and the use of rubber dispersions and solutions as adhesives. Equipment for the manufacture of adhesives is described.

Basic Mathematics for Engineers, by Paul G. Andres, Hugh J. Miser, and Haim Reingold; John Wiley and Sons, Inc., New York, 1944; 726 pages, $4.00.

A textbook about the mathematics required for elementary engineering courses also contains those topics from algebra, trigonometry, and analytic geometry which are needed in preparing for a course in calculus. A study of vectors and the elements of differential and integral calculus is included.

Groupe 303 (Group 303), by Arkady Fiedler; Les Editions Varietes, Montreal, 1944; 22 pages, $1.25.

A vivid account of the exploits, the sense of adventure, and the heroism of the group of Polish war fliers who assembled in England and joined the R.A.F. after their country had been occupied. The parts these men played in the defense of England during the German attacks in 1940 and 1941 are the high-lights of the book.

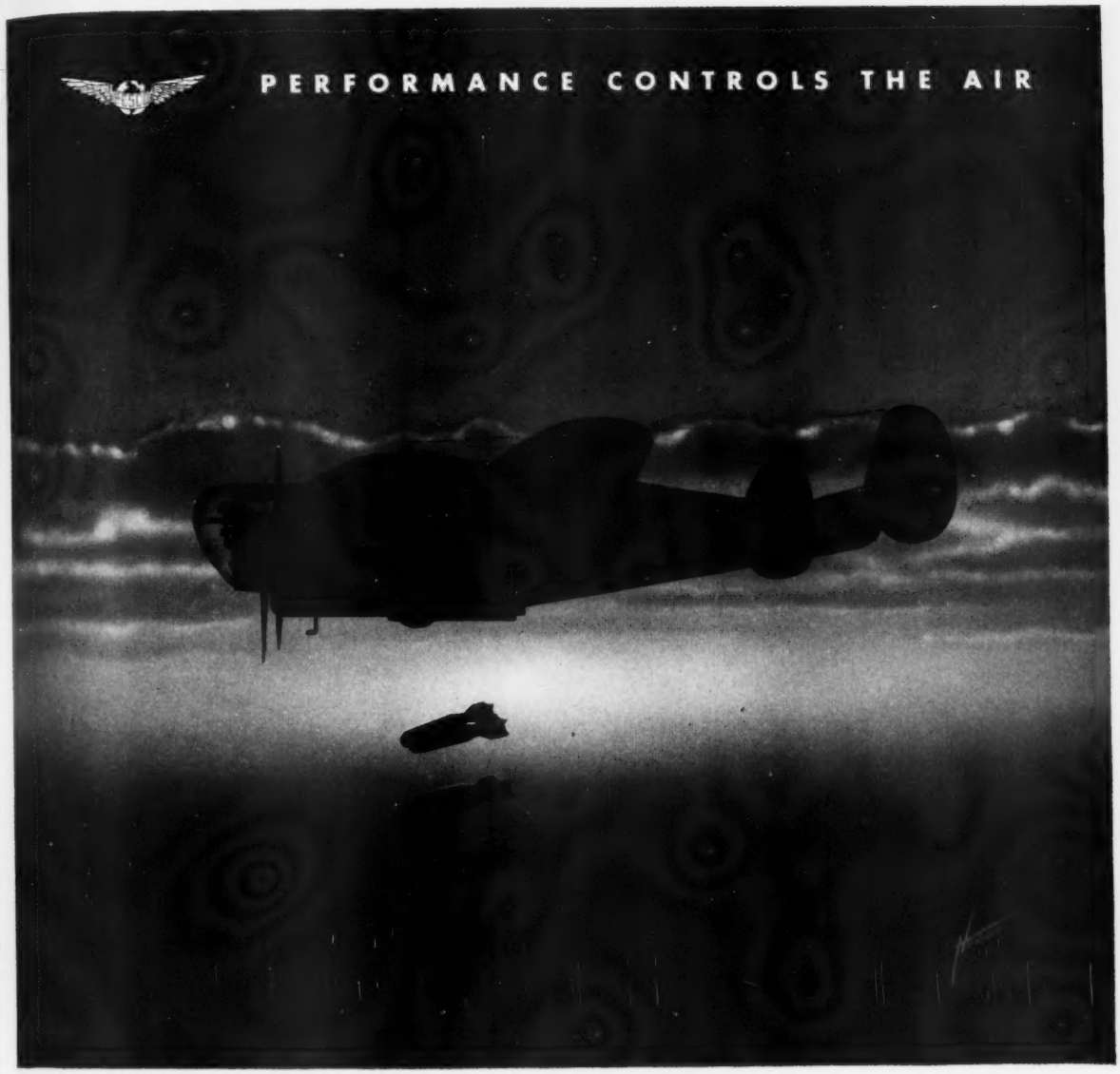
Aero-Engine Practice Simply Explained, by Group Captain Coats; Sir Isaac Pitman & Sons, Ltd., London, 1942; 38 pages, 9*d.*

In this booklet a practical description of the aircraft engine is given. Information is furnished in simple language about the component parts of the engine, testing, maintenance, and overhaul.

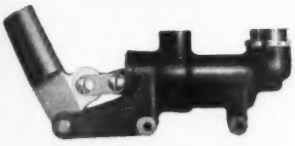
Materials Handbook, by George S. Brady; McGraw-Hill Book Company, Inc., New York, 1944; 765 pages, $5.00.

The fifth edition of a handbook containing basic data on industrial materials. It is a ready-reference book written to meet the primary requirements of industrial executives, engineers, purchasing agents, and others in industry. The scope has been extended to include the chief materials entering into import trade, because of the apparent widening interest in world trade materials caused by the war.

General information, with the most commonly used comparative figures, is given about materials in their group classifications in order to convey a broad picture. Patented and trade-named materials are then described to give a more specific understanding of commercial applications. Information concerning the chief ores and some processed industrial chemicals has been included.



BEECHCRAFT KANSAS. Designated the AT-11, this low wing, all-metal monoplane advanced trainer is used for specialized training of bombardiers and gunners. It is equipped with flexible guns and bomb racks for instruction of a crew of three or four.



PESCO HAND OPERATED HYDRAULIC PUMP

PESCO HAND OPERATED HYDRAULIC PUMP. Here's a pump of unusually high volumetric and mechanical efficiency. As an emergency pump for aircraft it delivers .125 g.p.m. at 20 cycles per minute with 1500 p.s.i. discharge pressure. Ideal for small quantities of fluid at high pressure. Compact, lightweight and self-lubricating, with spring-loaded ball check valves for unidirectional fluid flow, and needle bearings to minimize operating torque. Meets winterization requirements and is AN approved. Write for details. PESCO Products Co., 11610 Euclid Ave., Cleveland 6, Ohio (Division Borg-Warner).

What's new in Hydraulics? Write for this new book, "Pressurized Power and Controlled Flow by PESCO"

In Aircraft Hydraulics, Fuel Pumps, Air Pumps, Related Accessories...

PERFORMANCE POINTS TO Pesco FIRST

Mathematically, here's the inside story

THE FORMULA in the picture above is an expression of *bunching* as it takes place in the Klystron tube.

This Sperry tube converts DC energy into radio frequency energy by allowing an electron beam to become bunched, or pulsating, between spaced grids.

▶ **The ultra-high-frequency micro-waves thus generated can be concentrated into a narrow beam and directed with great accuracy.**

Various other forms of the Klystron have been developed by Sperry to aid in the amplification and reception of ultra-high-frequency waves. Today they are vital parts of many a device used by our Armed Forces.

The name "KLYSTRON" is a registered trade-mark of the Sperry Gyroscope Company, Inc. Like other Sperry devices, Klystrons are also being made during the emergency by other companies.

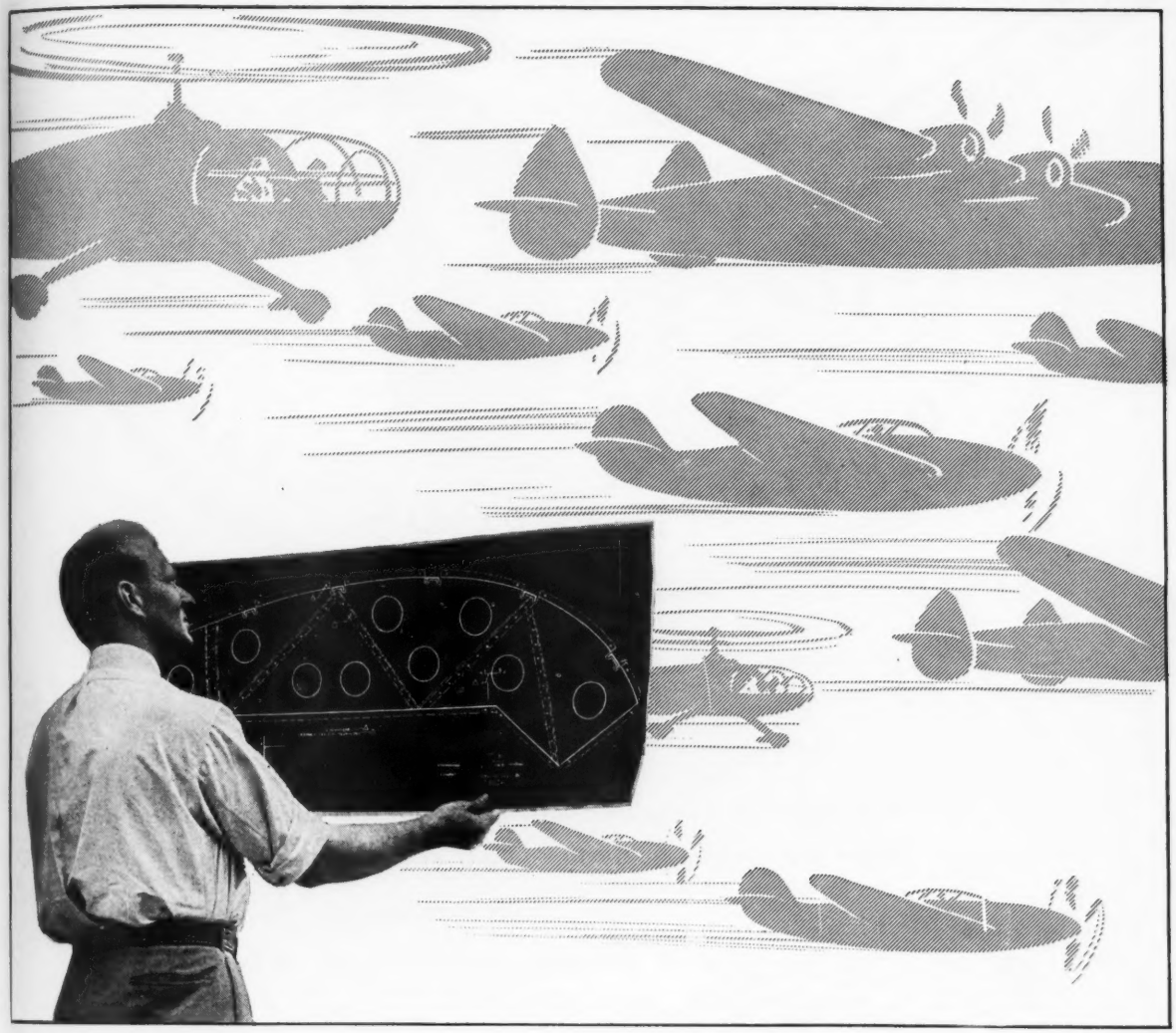
▶ **Klystrons are now being produced in quantities, and certain types are available. Write us for information.**

Sperry Gyroscope Company INC.

GREAT NECK, N. Y. • DIVISION OF THE SPERRY CORPORATION

GYROSCOPICS • ELECTRONICS • AUTOMATIC COMPUTATION • SERVO-MECHANISMS

★ NUMBER 10 IN A SERIES, TRACING FIFTEEN YEARS OF KELLETT AIRCRAFT HISTORY ★



New Kellett Reproduction Method Speeds Engineering—Cuts Costs

THE thousands of drawings, layouts, templates, router block and jig patterns required for production of a single type of plane emphasize the importance of the time and cost-saving benefits of the new Kellett Loft Reproduction System.

The method, which meets the wide range of requirements for photo-reproduction, requires only one hand-made layout, which is the original drafting board item. This is made on a matte finish vinylite —a readily-available, transparent, plastic sheet, which is impervious to moisture and possesses a very low co-efficient of thermal expansion.

Once checked, the vinylite drawing is used to make photographic copies on sensitized tracing cloth for blueprints, and on steel and other sensitized materials for templates, router blocks and jigs. Right or laterally-reversed images can be obtained with maximum accuracy.

The Kellett Loft Reproduction facilities are available to other manufacturers. For full details write Loft Reproduction Dept. B, Kellett Aircraft Corporation, State Road and Landsdowne Avenue, Upper Darby (Philadelphia), Pennsylvania.

KELLETT

OLDEST ROTARY WING AIRCRAFT MANUFACTURING COMPANY

Altair* VARIABLE ANGLE DRIVE

These new angle drives have four outstanding characteristics for use in connection with remote radio tuning or rotation of any item.

1. The drive can be rotated through 360°.
2. Fits standard type male and female shaft connections.
3. The unit is serviced by removal of one bolt – and without disturbing the shaft connections.
4. Serves as the anchor point for tach shaft installation.

Altair* Variable angle drives are available to fit both MC 164 and MC 215 tach shafts. Complete information will be supplied on request. Pacific Division, Bendix Aviation Corporation, North Hollywood, California. Sales Engineering offices in New York City and Dayton.

The new trade name of products manufactured by Pacific Division, Bendix Aviation Corporation.

Pacific Division
Bendix Aviation Corporation
NORTH HOLLYWOOD, CALIF.

DESIGNERS AND MANUFACTURERS OF RADIO AND HYDRAULIC EQUIPMENT—OUR PART OF THE INVISIBLE CEIL

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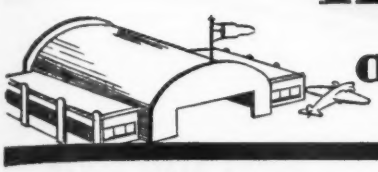
House Organs and Catalogues



Aircraft Specifications

A folder has been issued giving model plans and specifications for the Douglas C-54 transport plane. A general description of the plane is included, and design and performance data are given in text and tabular form. *Douglas Aircraft Company.*

Welding Equipment

Information about position welding is included in a 40-page bulletin designated as No. 2101. A description is given of positioning equipment designed to assist the welder in his work. These positioners range in size from small hand-operated units to heavy duty machines. *Ransome Machinery Company,* Dunellen, N. J.

Aircraft Engine Starters

Aviation Engine Starting Systems. An aviation accessory design check chart, designated as No. 8, gives details of Eclipse Series 48 combination inertia and direct-cranking electric starters. Starter applications, performance, and design features are listed. *Eclipse-Pioneer Division, Bendix Aviation Corporation.*

Dispatching Department

The Hurry-Hurry Gang. The specific duties of a dispatcher at Pratt & Whitney Aircraft Corporation are outlined. It is shown how the Dispatching Department is organized and how it operates to assure that the thousands of parts required for each Wasp engine arrive at the assembly floor at the proper time for assembly into the engine. *The Wasp Nest,* June, 1944.

Molded Plywood Products

A folder describes how wood and other fibrous materials are adapted to many uses by a special technique of low-pressure molding and permanent bonding. With this process, wood veneers and other fibrous laminates are bonded with phenolic resin under heat and pressure and at the same time molded into practically any shape desired. *Frank C. Snedaker & Company, Inc.,* Philadelphia.

Adhesive Data

3-M Adhesive Data for Sealing, Insulating, Adhering, Sound-Deadening, and Coating. A booklet has been issued containing data for the information of those using adhesives or coating materials, impregnators, spray-on insulators, and sound-deadening compounds. The formulas for various coating materials are listed, and information is given about the viscosity, bonding range, and methods of applying the products. *Minnesota Mining and Manufacturing Company,* Detroit.

Booklets on Welding Equipment

Eureka Tool Steel Welding Wires is a catalogue of 16 pages describing materials for use in welding all types of tool and die steels by the atomic-hydrogen, metallic-arc, and oxyacetylene methods. It contains information concerning the types of tool steels suitable for repair by welding, the advantages of welding in composite-die construction, and recommendations for the use of the materials in a broad variety of construction and maintenance work. Procedures are outlined for the application of the different kinds of electrodes listed, and typical examples of finished work are illustrated.

Suttonite No. 1 and a Newly Developed No. 2 is a folder that describes welding rods and fluxes developed for reclaiming cutting tools made of high-speed steel. The processes and materials are outlined, and directions are given for performing the work. Illustrations show examples of damaged tools and how they were restored to useful condition. An 8-page leaflet contains a reprint of an article about the reclamation of high-speed steel tools. *Welding Equipment & Supply Company,* Detroit.

Heat and Airflow Instruments

A 4-page leaflet shows some of the instruments and materials manufactured by the Revere Company for the control of heat and airflow. Among the apparatus shown are thermocouples of various kinds, leads, a pressure tube, a hot-gas probe, a pitot-static tube, a bayonet connector, eyelet terminals, eyelet and split-nut connectors, and wire. Aviation applications for these devices are listed. *The Revere Company,* Wallingford, Conn.

Propeller Manufacture

Advanced Design Precision Craftsmanship in Wood and Plastics. The services and products of U. S. Propellers, Inc., are described in an 8-page illustrated pamphlet. Information is given about the company's research, planning, engineering, and manufacturing operations with regard to wood and plastic parts for aircraft. *U. S. Propellers, Inc.,* Glendora, Calif.

Producing Synthetic Rubber

A Summary of Data on Synthetic Rubber. Revised as of July 1, 1944, a digest of information about synthetic rubber is presented. This summary reviews the nature of synthetic rubber, its historical development, its different types, the raw materials that are needed for its manufacture, and the Government program for its production. More detailed facts pertain to the manufacture and applications of Buna S, Neoprene, Buna N, Butyl, and Thiokol. *The Rubber Manufacturers Association, Inc.,* New York.

Electrical Connector Wall Chart

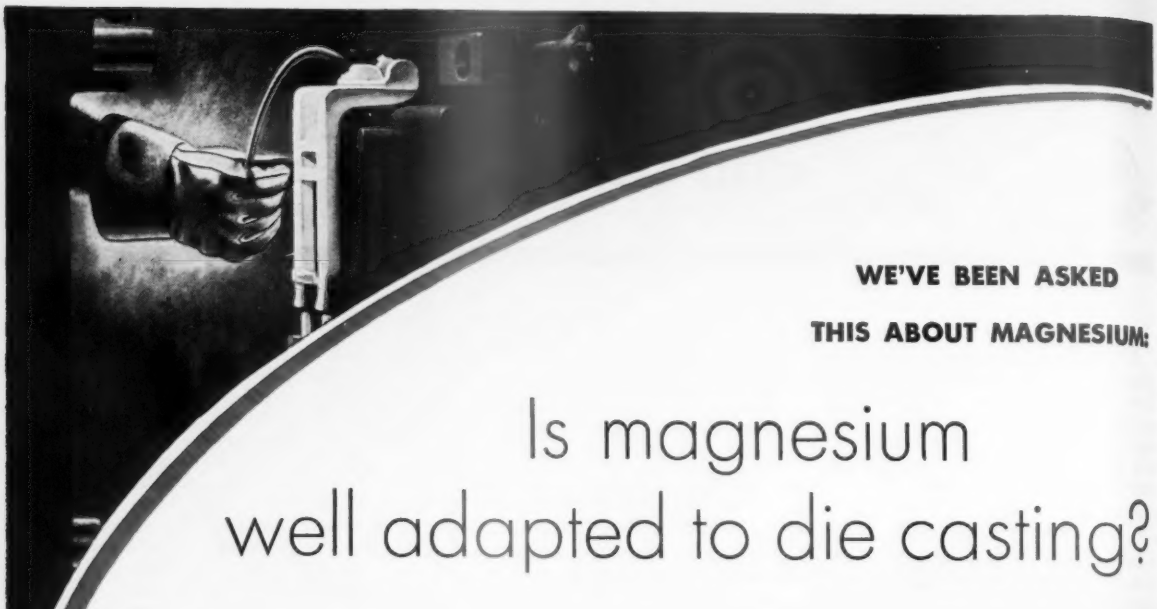
A wall chart is available which contains in condensed form information about Cannon Types K and RK electrical connectors. It is recommended for use by aviation schools, aircraft plants, air depots, flying fields, aircraft repair shops, etc., for instruction, identification, assembly, ordering, servicing, or repair of these connectors and their accessories. In addition to listing 189 full-scale insert arrangements, the chart shows total contacts, identification numbers, wires and contact data, and clearance. *Cannon Electric Development Company,* Los Angeles.

New Standard Sheets for Pratt & Whitney Loose-Leaf Manual

Unrestricted Current Production Engines. Descriptive data together with performance and dimension figures are given for Pratt & Whitney aircraft engines. The information pertains only to engines that are currently in production and about which details have not been restricted. Covering Wasp Jr., Wasp, Twin Wasp, and Double Wasp engines, these new and revised technical data sheets are distributed for insertion into the Pratt & Whitney loose-leaf manual. *Pratt & Whitney Aircraft, Division of United Aircraft Corporation.*

New Data Sheets for Pioneer Instruments

Several new publications have been issued for insertion in the *Pioneer Instruments Manual.* Three are Test Procedure sheets: No. 41-11, on autosyn oil temperature transmitters and autosyn carburetor-mixture and air-temperature transmitters; No. 42-3, on inverters; and No. 43-23A, on centrifugal tachometers. Three of the publications are Service Bulletins relating to im-



WE'VE BEEN ASKED

THIS ABOUT MAGNESIUM:

Is magnesium well adapted to die casting?

Sound, strong die castings of the highest quality are produced from Dowmetal Magnesium Alloys. The advantages of die casting techniques, combined with the high strength-weight ratio of magnesium alloys, make possible products which are strong, lighter in weight, yet comparable in price with die castings in other metals.

This aircraft cover plate is but one of many instances where Dowmetal's die casting properties have proved outstanding.

The surface finish of Dowmetal die castings is excellent . . . thinner sections are possible than with sand or permanent mold castings . . . accuracy and close dimensional tolerances reduce machining to a minimum. Dowmetal's low cost in large-run production is likewise an important consideration.

Since 1916 Dow has been producing, alloying and fabricating magnesium. The benefits of the accumulated knowledge, as well as the facilities of Dow's own fabrication shops, are readily available to those interested in Dowmetal die casting as a means of improving their products. Inquiries are welcome.

DOWMETAL *magnesium*

THE METAL OF MOTION

DOWMETAL

MAGNESIUM DIVISION • THE DOW CHEMICAL COMPANY

MIDLAND, MICHIGAN

New York • Boston • Philadelphia • Washington • Cleveland • Detroit • Chicago • St. Louis • Houston • San Francisco • Los Angeles • Seattle

proved diaphragm assembly and replacement of diaphragm strap; No. 42-21A pertains to autosyn differential fuel pressure transmitters; No. 42-21B to manifold pressure gauges; No. 42-21C to autosyn manifold pressure transmitters. There is one overhaul manual, No. 43-30B, relative to centrifugal tachometers, and an installation and line maintenance sheet for autosyn temperature transmitters, No. 43-1A, superseding No. 16-4. *Eclipse-Pioneer Division, Bendix Aviation Corporation.*

Belt Conveyer for Cargo Loading

Cargoveyer Meets Plane Loading Problem. Joe Stout, Jr. Details are given about a conveyer developed by Pennsylvania Central Airlines for loading cargo onto a plane. The device consists of an electrically driven belt mounted on a four-wheel chassis. Cargo is placed on the belt at ground level and carried by it up to the plane. For unloading the direction of the belt is reversed. *PCA News*, June, 1944.

Applications of Aircraft Equipment

Simmonds Products Fly with Famous Planes contains a partial list of the accessories used in present military and commercial airplanes, and a report on some of the development work in progress in connection with aeronautical equipment for the future. Among the items noted particularly are automatic engine controls, push-pull controls, ignition apparatus, hydraulic equipment, and the chronometric radiosonde. Other pages show the manufacturer's facilities, research work, and engineering services for industries outside the aircraft field. *Simmonds Aerocessories, Inc.*, New York.

Conversion to War Work

Peacetime Enterprise Put to War Work is the title of a booklet that shows how the facilities of a large manufacturer of automotive vehicles were converted to the production of war equipment. Among the most important items being produced for war work are wing and fuselage sections for airplanes, landing gears, aircraft engines, and parts. Other kinds of war equipment described and illustrated are Army tanks, trucks, ammunition, smoke-screen generators, refrigerating and heating equipment, antiaircraft guns, gyro compasses, harbor craft, searchlight reflectors, and airraid sirens and fire-fighting equipment. The engineering and manufacturing facilities of the company are described. *Chrysler Corporation.*

Study of Wear

Wear: A Discussion of the Mechanism of Wear Phenomena and Influencing Factors is the title of a 46-page booklet containing a compilation of facts concerning the action that takes place when materials are subjected to relative motion. Definitions are given of the different kinds of wear, and methods are suggested for treating metals in such a way as to resist the effects of wear. Some of the subject headings are as follows: The Mechanism of Wear; Wear and Physical Properties; Molecular Adhesion; Surface Melting; Specific Pressures; Lubricants and Wear; Galling; Scoring; Fretting; Gear Pitting; Work Hardening; Chemical Effects; Wear In; Wear Out; Wear of Nitralloy vs. Other Steels; Surface Finish and Wear.

A section is given to a discussion of cylinder and piston wear with reference to automotive and aircraft engines. In this section there are tables of cylinder and lining materials and a discussion of the properties of nitrided cylinders, piston-ring wear, and other related subjects. Another section discusses nitrided gears in aircraft engines and various methods of finishing metal surfaces. *The Nitralloy Corporation*, New York.

Slow-Motion Bombs

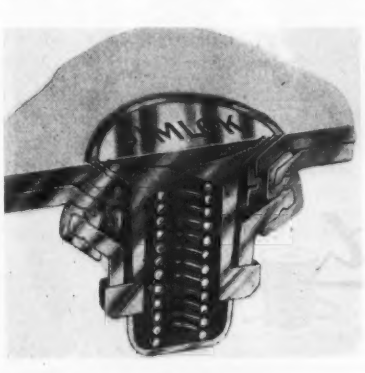
Parachute Bombs. A description of the technique by which clusters of 20-lb. fragmentation bombs, attached to parachutes, are dropped from combat planes. These parachute bombs are used mainly as antipersonnel weapons, and methods of employing them are being developed at the Army Air Forces Tactical Center in Orlando, Fla. As noted, the purpose of the parachute attachment is to permit the low-flying plane to get away from the explosion. *Douglas Airview*, June, 1944.

Shearing and Routing Department

Tailoring Cobras. The functions of Bell Aircraft's Shearing and Routing Department are recorded. This is the department where the surface parts of wings and fuselage are sheared from raw sheet metal, stack drilled, and routed to dovetail into a perfect contour. As described, the routing operation is a process for shaping parts that are curved or have irregular edges. *The Bellringer*, June, 1944.

Hole Punching Equipment

Catalog BC describes the construction and operation of machines for punching large numbers of holes in metal or in metal materials according to specified hole patterns. These machines are designed to punch holes in curved or rectangular sheets or strips on a high-production basis. The catalogue includes drawings, photographs, and specifications of various types of standard accessories of use with the machines. *Wales-Strippit Corporation*, North Tonawanda, N.Y.



The Simlok fastener in the locked position. When unlocked, the stud is self-ejecting, being forced up by the spring.

Electronic Products

Norelco Electronic Products is a 24-page illustrated catalogue. It traces the history of the establishment of extensive facilities in America to carry on the business of a large manufacturer of electric and electronic equipment formerly located in the Netherlands. It explains the incorporation and ownership of the American branch and describes and illustrates the facilities acquired in the United States. The products manufactured include a wide variety of electrical devices for lighting, radio, X-ray and numerous products in the electronic field. The parent company's facilities in Holland also are described and illustrated. *North American Philips Company, Inc.*, New York.

Fastener Catalogue

Simlok, the Fastener of Today with the Design of Tomorrow is a 16-page catalogue describing the improvements in the design of fasteners and the uses to which the new Simlok fastener can be applied. It emphasizes the features of this particular fastener, including the basic principle upon which it functions for fastening and unfastening two sheets of metal or plywood. Among the features noted are the standard stud, which is self-ejecting when unlocked; a case-hardened threaded receptacle; safety ring; splines for locking the receptacle in the desired position; and the lock ring for permanent installation.

Suggestions are included for the use of the fastener in the aircraft and other industries. *Simlock Division of Simmons Machine Tool Corporation*, Albany, N.Y.

Production Incentives

How "Jahco" Achieves Production is the title of a booklet illustrated by many photographs, in which are explained the business principles that have resulted in a high degree of cooperation between management and labor. It outlines the attitude of management toward the associates who are employed in the plants and tells of the services and benefits provided by the management for the employees. *Jack & Heintz, Inc.*, Bedford, O.

History of an Aircraft Builder

A 4-page folder gives a brief history of the McDonnell Aircraft Corporation, reviewing the work that the company is doing in the war effort. It refers particularly to the manufacture of the AT-21MM crew trainer at the company's Memphis Division. Photographs show sequences in the production of the airplane. *McDonnell Aircraft Corporation.*

Precision Measuring Device

Millionths of an Inch for Sale by Vinco is the title of a catalogue, illus-

Sea Level to Stratosphere

The Packard high-altitude cable that helps keep fighter and bomber engines roaring eight miles above the earth represents a lot of research and engineering development, with a sound background of manufacturing experience. For the problem was to build a cable that was right for all altitudes and conditions . . . from sea level take-off in tropical heat, to a ceiling where the temperature may be 62° below zero and the air is one-fourth normal density.

Packard Electric engineers found the answer in a cable with tough synthetic rubber sheathing over an inner reinforcing braid—manufactured with care and precision, from the first wire-drawing operation to the final coating. Extremes of heat and cold, the excessive corona conditions of stratosphere flight, oil, moisture and vibration—they have met their match in Packard high-altitude cable.

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trated in color, showing various instruments for the precision-measuring of aircraft parts. These include the cylindrical gauges, straight-side spline gauges, gauges and masters for thread rings, serration splines, involute splines, master gauges, gear-rolling fixtures, optical inspection dividing heads, checkers, grinders, and other devices. *Vinco Corporation*, Detroit.

Fastening Devices for Airplanes

Flying Fasteners for America's War Planes. C. F. Newpher. The functions and importance of the various types of fasteners in an aircraft structure are described. Special usages of "cowl" fasteners, blind riveting, bolts, nuts, and screws are among those mentioned. *Fasteners*, Vol. 1, No. 2.

Condensed Catalogue of Lathes

South Bend Precision Lathes is a new, condensed catalogue showing a group of engine-, toolroom, and precision turret lathes for production, toolroom, and maintenance work. It is designated as Catalogue No. 150. *South Bend Lathe Works*, South Bend, Ind.

Bulletin of Gasket Materials

Synthetic Gasket Materials and Mastic Compounds is a bulletin of 4 pages giving technical information about materials and methods used in sealing Plexiglas. It refers to the gasket materials and mastic compounds and explains test methods and results. A table gives data about the properties of various materials provided by the manufacturer for use with Plexiglas. *Rohm & Haas Company*, Philadelphia.

National Aircraft Standards

New and revised National Aircraft Standards have been issued as follows: NAS 17, 18, 19, electrical connector panels; NAS 67, Dzus Type low-form cowl-fastener guide; NAS 53–66 close-tolerance bolts; NAS 143, washer; NAS 144–158, 172, 174, and 176, internal wrenching bolts. *National Aircraft Standards Committee.*

Improved Operation Method

Draw Dies Score at Bomber Plant. Reporting the installation of draw-die methods at the Georgia plant of Bell Aircraft, this article describes the construction and operation of the dies. It also indicates the advantages of the draw dies and compares the results achieved from their use with those from corresponding drop-hammer dies. Made of Kirksite, the new dies are of standard three-piece construction for single-action presses equipped with die cushions. The presses used are of 275- to 500-ton capacity on the ram, with 75- and 175-ton capacity on the die cushion. Claims made for the draw dies are that they have reduced labor cost per part, eliminated planishing operations, reduced scrap, and almost completely eliminated reworking of worn or broken dies. *The Bellringer*, June, 1944.

EVERY HELICOPTER RECORD BROKEN.. with Franklin POWER

ON MARCH 2, 1944, the Army's latest helicopter, the Sikorsky XR-6, powered by a 245 horsepower Franklin engine, flew non-stop from Washington, D. C. to Patterson Field, Dayton, Ohio. With Col. H. F. Gregory at the controls, this flight unofficially broke every existing helicopter record.

A new distance record was established—387 miles, non-stop. The XR-6 remained in the air 4 hours and 55 minutes—a new endurance record. It flew the Alleghanies at 5000 feet, carrying pilot and passenger—higher than any helicopter ever before had flown with such a load. Ground speed for the flight averaged approximately 80 m.p.h. —new record cross-country time for a helicopter—made despite headwinds from 10 to 30 m.p.h.

Thus the XR-6 dramatically proved itself a practical flying machine, definitely out of the purely experimental stage. And thus another string of "firsts" was added to the long series already held by Franklin engines in the realm of power for flight.

Aircooled Motors Corporation engineers are even now planning new Franklin "firsts"—new and finer engines for your post-war aircraft. *Specify Franklin power.*

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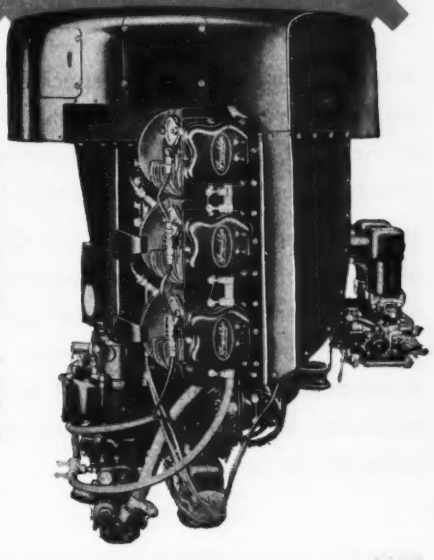

Franklin
AIRCRAFT ENGINES

FRANKLIN ENGINE 6ACV-405, powerplant for the Army's newest helicopter, the Sikorsky XR-6, shown above.

Fighting Aircraft Must Have

GOOD ARTERIES

When the aircraft designer specifies Flex-O-Tube, he gives the future crew of that plane the best possible protection of their fuel, oil, hydraulic and instrument lines against the effects of vibration, twisting and wide temperature variations.

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Weld-Testing Machine

The Airco Tensile and Guided Bend Testing Machine is described in a catalogue of 16 pages. It gives instructions for the operation of the machine and a description of its construction, as well as specifications. Instructions are also given for the preparation of the machine for test work and preparation of specimens for standard tests. It also tells how test results should be calculated. *Air Reduction Sales Company*, New York.

Postwar Planning

Testimony Regarding General Motors Postwar Program. The testimony of C. E. Wilson, President of General Motors Corporation, before the Special Committee of Postwar Economic Policy and Planning of the House of Representatives has been reprinted in a booklet of 48 pages. It includes a tabulation referred to in the statement, giving figures about average employment in various industries for the years 1939–1943, inclusive. *General Motors Corporation.*

Record of Air Power

Air Power is a 23-page review of the development of the aeronautical industries in America and of the steps taken by various Government departments toward the development of a national policy concerning aviation. It contains recommendations for the establishment of an air-power policy for the future. *Aeronautical Chamber of Commerce of America, Inc.*, Washington.

South African Air Force

How Springbok Airmen Mauled the Axis. Brigadier J. Holthouse. This article commends the record of the South African Air Force in the present war. It briefly reviews the rapid expansion of aeronautical training and industrial facilities in South Africa since 1939, the operations of the Air Force in Italian Somaliland and Ethiopia, and the role of the Springbok airmen in protecting Allied shipping lanes. It also tells how equipment from the United States aided in the development of the South African aviation industry. Factual information about South Africa's population, resources, political history, leaders, etc., is included. *The Pegasus*, July, 1944.

British Engineering Standards

Drawing Office Organisation is one of a series of booklets containing information about engineering work in the factories. This booklet explains the work of drafting departments and how they should be organized. Advice is given concerning the design of drafting rooms, equipment, personnel and organization, recruiting and training of draftsmen, and the planning, execution, filing, and care of engineering drawings. This booklet is B.S. 1100: Part 9: 1944.

British Standard Specifications for Aircraft Materials are issued in loose-leaf form and revised from time to time. Recent revisions include: B.S. No. 5. S. P. 4., relating to steel pins; B.S. No. 5. V. 11., relating to dry gelatine glue; and B.S. No. 6. V. 10., referring to liquid and gelatine glues. Price, 1*s.* for each number. *British Standards Institution*, London.

Aircraft Jacks

Catalog No. 112 describes and illustrates Malabar aircraft jacks. It describes the numerous types of hydraulic jacks, with variations and modifications necessary to meet the requirements of all types of aircraft. It gives specifications, together with drawings and photographs, of different types of jacks and special devices of similar nature, such as hydraulic weight indicators, adapters, and parts. *Malabar Machine Company*, Los Angeles.

Maintenance Charts for Spray-Painting Equipment

Two wall charts have been prepared to help users of spray-painting equipment make their present units last as long as possible. One is called a Conditioning Table and consists of illustrations accompanied by simple directions to show operators the most important steps to follow in caring for spray guns, paint cups, hose, transformers, air compressors, spray booths, and exhaust fans.

The other is a chart showing how to maintain air compressors and take proper care of such equipment. It shows the routine that should be followed in periodic inspection of the various parts and a time chart for scheduling the work to be done daily, weekly, and monthly. *The DeVilbiss Company*, Toledo.

Aeronautical Rubber Products

A catalogue of aeronautical products other than tires discusses the new "bladder"-type synthetic-rubber fuel cells and other products made of rubber for aircraft use.

Two pages of the new catalogue are given to a discussion of the deicer, with comprehensive sketches and an outline of the data needed for deicer design. One page shows details of the electrically heated propeller shoe, a new product.

Four pages are given to the Rivnut, the blind fastener that serves as a nutplate, rivet, or both. Step-by-step Rivnut installation is pictured, together with complete instructions and a chart listing all sizes and types. Other parts of the catalogue describe hose, molded goods, and other rubber products for airplane use. *The B. F. Goodrich Company, Aeronautical Division.*

Helicopter Designer

Building Vertical Skyways. This is a brief biography of Arthur M. Young, head of Bell Aircraft's helicopter unit. Telling of his 15 years of research to achieve stability in rotating wing aircraft, it traces the inventor's career from his college days until the completion of the first Bell helicopter. *The Bell-ringer*, June, 1944.

Aircraft in Combat Areas

Curtiss Aircraft in Combat and Commerce is the title of a 32-page booklet containing photographs, three-view drawings, and descriptive data about modern Curtiss planes. Information is given concerning the services rendered in combat and training areas throughout the world. The photographs include flight views, carrier views, and ground views of the planes. *Curtiss-Wright Corporation.*

Feeder-Line Airplane

The Douglas "Skybus" is a booklet containing an engineering presentation of a feeder-line airplane for postwar operations. Called the "Skybus," this plane is a high-wing, twin-engined, all-metal monoplane with tricycle landing gear. It has a high-wing feature that permits downward vision for sightseeing.

Although primarily designed for efficiency and economical operation, the Skybus is reported to encompass high performance, maneuverability in the air and on the ground, and ability to take off and land on small airports. Its pay load provides for a maximum of 24 passengers and cargo. With this airplane, at maximum take-off gross weight of 17,300 lbs., a cruising speed of 190 m.p.h. at 5,000 ft. on 60 per cent rated power is obtained. Better than 11,000 ft. altitude may be maintained with one engine out. The stalling speed is less than 65 m.p.h. *Douglas Aircraft Company, Inc.*

Continuous Power Conveyer

Catalog No. A-83 describes and illustrates the Zig-Zag continuous power conveyer. Features of this design, according to the manufacturer, are that it meets the requirements for handling loads at slow speed and is able to negotiate short-radius horizontal and vertical curves proportioned to the product to be carried. The conveyer is designed to carry loads on 6-in. centers with a maximum loading capacity of 125 lbs. per ft. on the conveyer. The equipment is powered by single or multiple, forward and reversible drive units. The catalogue gives the methods for measuring curves and formulas for determining the load track and curves for a conveyer system, together with other technical information about suspension methods, fittings, and equipment necessary for the installation of a conveyer system of this type. Illustrations of installations in various types of industrial plants are included, as well as specifications for the various parts and accessories used in a conveyer line. *Richards-Wilcox Manufacturing Company*, Aurora, Ill.

Laminated Plastics

What Formica Is is a small booklet of 31 pages that explains the nature and use of Formica laminated plastic material. The uses of the product in many industries are explained, including the manufacture of pulleys, fair-lead bush-

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ings, and machine parts used in the construction of aircraft. *Formica Insulation Company*, Cincinnati.

Postwar Landing Areas

Research Safeguards the Future. Oliver L. Parks. Predicting the increasing utility of private planes after the war, the writer offers suggestions for assuring adequate landing facilities to accommodate the expected volume of air traffic. He outlines the features of a proposed airport plan and presents figures on estimated costs. *The Pegasus*, July, 1944.

Production Suggestions

"Now is the Time to Be Suggestive." Production innovations made at Douglas Aircraft Company, Inc., resulted in the following efficiencies and economies: (1) countersinking holes in the lower surface of a drop-hammer head eliminated jamming of stud bolts against the surface through misalignment and allowed easy access of the bolts into the hammer head when installing and setting up dies; (2) improved collet bodies for Morey turret lathes enable work to be held securely in collet, decrease tool and part breakage, and aid production of small parts; (3) assembly jig for installation of airplane ribs allows one person to drive and buck rivets; (4) assembly jig for locating clips on wing-panel assembly saves production time; (5) improved machine for dual-roll Rockwell inspection of extrusions has two rolls stamping 500 ft. of extrusion per min.; (6) outer wing fixture results in decrease of time in changing wings from racks in which they are shipped from vendors; (7) improved installation anchor nut plates at hinges, which range from universal to left-hand and right-hand eliminate time lost in misalignment and relocating; (8) universal height gauge attachment measures inner surfaces not accessible to ordinary precision instruments; (9) replacing screws with AN bolts on fuselage plating installation fastens work more securely; (10) holding fixture for nonram carburetor filter-duct assembly enables one person to do the job of two during installation of nut plates; (11) combination stop countersink and angle tool is adjustable for countersinking different sizes and allows the work to be performed in inaccessible places; (12) a joggle die combines a standard hat section, channel section, Z- and bulb angles, all formerly requiring separate dies; (13) a trimming attachment for bomb-door tracks eliminates hand filing and saves time; (14) tool for removing bell-crank fittings on outboard wing dive brakes removes fittings and torque shaft easily; (15) nut plate pressure pad, applicable to all aircraft using Erco riveting machines, eliminates gang drilling holes, predimpling for flush riveting, and the placing of rivets by hand; (16) fixture that permits armor plate to be installed with proper clearance eliminates time lost in reworking plate to fit after riveting. *Douglas Airview*, June, 1944.

Employees' Ideas Spell Victory for Allies, Doom for Axis, and Bonds for Workers. Two ideas submitted by employees of the Globe Aircraft Corporation were put into operation by the company. These are: (1) a suggestion for greater utilization of a jig in control surface assembly, and (2) the use of a depth gauge in fitting and dressing down gasoline-tank lids. *The Globe Beam*, May, 1944.

Suggestion Plan Proves Friend in Need. Noorduyn employees received awards for the following production suggestions: (1) a drill guard that fits over the head of the rivet and prevents the drill from slipping during the repair operation of removing rivets; (2) a jig to replace the old block method of manufacturing pin-wheel lower fairings; (3) a set of straps to hold monocoque skins in position while they are being fitted into the assembly; (4) a block that enables the combining of operations in the fabrication of elevator trailing edges; (5) the elimination of crimping-machine operations through the use of a forming block. *Noorduyn Tale-Spin*, June, 1944.

Idea Awards Total $1,812. Among the top awards for production suggestions made by Consolidated Vultee personnel was one for stripping tools for small drill armatures wound in the electrical maintenance department. *The Eagle*, June 1, 1944.

J. B. Hamilton Joins Idea-men's Topnotcher Club. A "topnotch" award was made to a Consolidated Vultee employee who devised a jig for holding shipping boxes and crates during their construction. *The Consolidated Vultee Volunteer*, June 9, 1944.

Suggestions Honored. Production awards were won at North American Aviation for the following suggestions: (1) a method of preheating carbon-pile type voltage regulators; (2) installation of a hoist and monorail for master mating jigs; (3) adjustable spline-nut pliers to operate any size of electric plug connection. *Production Drive News of the Skywriter*, June 9, 1944.

March Suggestion Award Winners at East Hartford. Hamilton Standard Propellers Division of the United Aircraft Corporation selected the following among the best production suggestions submitted by employees during the month of March: (1) a hydraulic control for a Sundstrand milling machine that automatically brings the cutters back to their starting point and prevents them and the adapters from smashing into the work; (2) a tool to press seven holes in a neoprene gasket with one punch; (3) indicators that record eccentricity between surfaces of a bearing shaft. *Hamilton Standard Blade*, June 15, 1944.

Six Given $209 for Suggestions. By suggesting a movable table for a drill press, an employee of Consolidated Vultee Aircraft Corporation at Ft. Worth won a prize awarded by the employee suggestion committee. *The Eagle*, June 8, 1944.

Dept. 1 Sweeps Up Most of the Idea Awards. The leading prize winner for the week ending June 16 at North American Aviation was a suggestion for a new part holder that is reported to have speeded production on required belt-sanding operations more than 100 per cent. This device utilizes the lever principle in belt-sanding operations. *North Ameri-Kansan*, June 16, 1944.

The Power of Suggestion. Prizes were awarded at the Ryan Aeronautical Company for these production suggestions: (1) a screw jack for use in setting the blanking dies in punch presses; (2) adjustable stops for spot welding of doublers; (3) use of an air motor attachment for the roller in the Drop Hammer Department, which permits one man to perform an operation that formerly required two; (4) a holder for use in shaping spot-welded tips. *Ryan Flying Reporter*, June 9, 1944.

$535 Shared by Plant Suggestion Award Winners. Highest production-suggestion award at the Texas Division of North American Aviation for the week ending June 23 was given for an idea that facilitated the handling of Dzus fastener springs through a method of feeding the springs one at a time. *Take-Off*, June 23, 1944.

Announce Prize Winners in Production Contest. Employees of the Ranger Aircraft Engine Division of Fairchild Engine & Airplane Corporation won awards for these production suggestions: (1) a better method of refinishing test propellers; (2) a bushing puller that can prevent the scrapping of finished crankcases; (3) a change in 6-cylinder hold-down studs which speeds the fastening of the hold-down nuts; (4) a new type of drill jig for targeting and drilling holes in impellers; (5) a change in the processing of air-scoop supports; (6) an improved system of removing small, broken drills from parts; (7) a better way of protecting the leading edge of test propellers; (8) a method of holding crankcases while the ends are finish-turned on a lathe. *Ranger's Cloud Buster*, June 5, 1944.

PAC Picks Annual Winners. First two prizes in General Aircraft Corporation's production suggestion contest for the month of April were won by the following innovations: (1) a portable Magnaflux inspecting machine; (2) a rolling drill stand. *Skyfarer*, June 2, 1944.

Their Ideas Speed War. Three suggestions for speeding and simplifying plane production through additional and improved plant tools merited prizes for employees of Douglas Aircraft Company. The innovations were: (1) the use of a sheet of pliable rubber on the stretch press in place of grease, which allows the metal to stretch without breaking; (2) a more efficient shrinking die; (3) a spring-winding tool which, it is claimed, can make any kind or size of spring faster and cheaper than it can be made on a machine or lathe. *Douglas Airview News (Tulsa)*, June 9, 1944.

15 Share $187 in Idea Awards. Prizes for two suggestions, one an adjustable gauge for a gang punch, the other a nut plate installation for the center section of an aircraft, were won by employees of Consolidated Vultee's Nashville Division. *The Consolidated Vultee Volunteer*, June 23, 1944.

Semi-Annual Awards of $2,700 to Be Presented to 17 Employees. In the semi-annual awards made by the Chance Vought Aircraft Division of United Aircraft Corporation, recognition was given for the following production suggestions: (1) a hoist sling for moving the main beam from jig to jig, which, aside from being a timesaver, removes a source of possible injury; (2) a system for distributing lubricating oil from Plews Oilers on main beam jigs, which prolongs the life of tools and avoids causes for injury; (3) equipment for permitting variable speed in drilling and reaming CM steel hinge fittings on the main beam, which has resulted in a saving of tools; (4) revision of operations in the tube-bending department, which reduced the number of required operations from 18 to 10; (5) a design for a new router adapter; (6) an idea for aiding installation and servicing of landing-gear controls; (7) a device enabling the quantity painting of small parts; (8) a design for dies and nest bars that permits gang braking of clips on punch presses; (9) a new method for installing clips. *The Chance Vought News*, June 22, 1944.

Ideas Win Victories. Awards were made for the following production suggestions made by personnel of North American Aviation: (1) new safety latch for pneumatic gun; (2) joggled die for forming preheat-treated material; (3) wedge for eliminating possibility of damage to nose-gear assembly when towing aircraft; (4) improved charts for checking wire assemblies; (5) screwing of eye bolts into iron inserts, which saves considerable time in handling Kirksite dies to be remelted, and also aids in retrieving inserts from melting pots; (6) attachment on the Southern bender for forming parts of the outer wing leading edge, which cuts operating time by two-thirds; (7) grooving of wedge blocks for hydropress form dies, which facilitates handling; (8) funnel-shaped cap, which, placed over one end of heat duct, saves time in applying machine-sewed insulations for heat ducts. *North American Skyliner*, May-June, 1944.

Winner of North American Aviation Corporation's suggestion contest for the week ending June 30 was an employee whose idea resulted in the improvement of the form die for tank straps. *The North Ameri-Kansan*, June 30, 1944.

L-M Committee Oks 12 More Suggestions. Awards for production ideas at the Curtiss-Wright St. Louis plant included those made for the following suggestions: (1) a fixture that holds 40 parts while the centers are being sawed out; (2) a jig to hold the airplane nose assembly during the installation of skins; (3) a system of placing the jig for the skin nose assembly on wooden horses instead of a table so that all rivets can be driven without moving the assembly; (4) a new method of pressure-testing fuel tanks for more accurate inspection; (5) cutting a slot in the template for the pulley bracket assembly to allow the template to slip in and out of the bracket; (6) a new hole-finder for locating holes in the deicer strips. *The Curtiss Wright-er*, June 2, 1944.

T. E. Ryan Wins Topnotcher Award. Production suggestions meriting awards at Consolidated Vultee's Nashville Division were these: (1) an improved method of providing slug clearance in die plates; (2) a movable boresight target; (3) an attachment for grinding serrating mill cutters. *The Consolidated Vultee Volunteer*, June 2, 1944.

Gupton Idea Seals Pores of Cast Aluminum. An employee at North American Aviation Corporation won a prize with the following production suggestion: By soaking aluminum castings in a barrel, in which both vacuum and air pressure insure proper sealing of the pores, 30 to 50 castings are treated simultaneously with sodium silicate, whereas formerly each part was fastened to a jig for a dipping operation. *North Ameri-Kansan*, June 23, 1944.

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Here's our answer to that question, based on many years' experience: consider the special application motor problem in the *early* stages of product development!

Discussion of the motor before the product design has been completely worked out will frequently save time and money.

Perhaps our motor experience will be of value to your engineering department. We shall be very glad to work with them.

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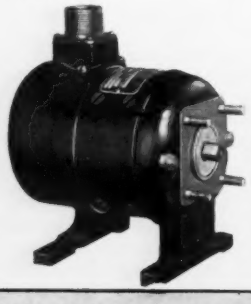

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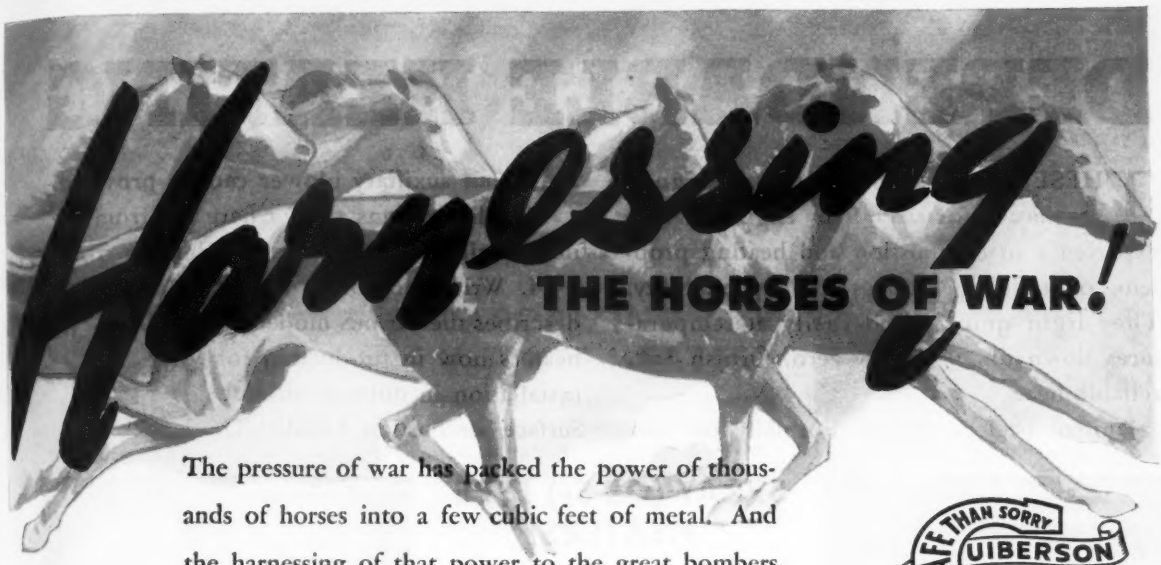

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The pressure of war has packed the power of thousands of horses into a few cubic feet of metal. And the harnessing of that power to the great bombers that daily are roaring to victory over Berlin and Truk requires master engineering and precision manufacture. The *MOTOR MOUNTS* for some of America's newest and largest bombers are being produced in the completely modern plants of the Guiberson Corporation. Care and precision in manufacture are the heritage of every Guiberson built aircraft part.

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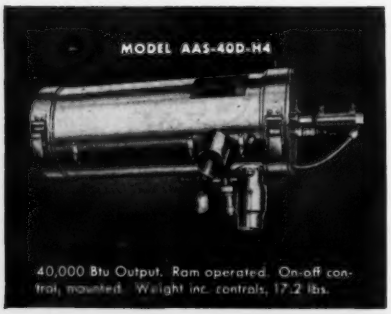
DEPENDABLE HEATING

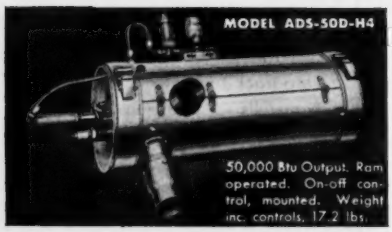
THESE light-weight heaters, designed specifically for aircraft by engineers with experience in combustion and heating problems, offer the highest degree of dependability. They light quickly and easily at temperatures down to 70° below zero, furnish fast, reliable heat.

Janitrol heaters operate normally on ram air, or an auxiliary blower can be provided.

The illustrations shown here are from the new Engineering Specification Bulletin, Form 3-44. Write for your copy. It describes the various models of heaters now in production for installation in military aircraft. Surface Combustion, Toledo 1, O.



40,000 Btu Output. Ram operated. On-off control, mounted. Weight inc. controls, 17.2 lbs.



50,000 Btu Output. Ram operated. On-off control, mounted. Weight inc. controls, 17.2 lbs.

100,000 Btu Output. Ram operated. On-off control, mounted. Weight inc. combustion air control, 23.8 lbs.

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The S- or spray type heaters, shown on this page, are designed for use in high or low speed and high or low altitude airplanes where relatively large capacities are required. They are equipped with spray type pressure burners using fuel under positive pressure. These heaters are equipped with glow plug ignition.

Surface Combustion Janitrol aircraft heaters operate on the unique "Whirling Flame" principle which works at high or low altitude.

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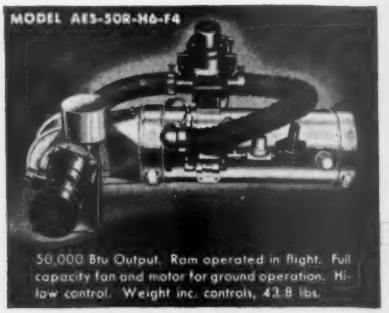
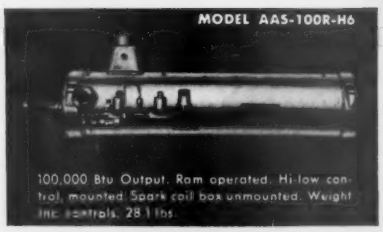
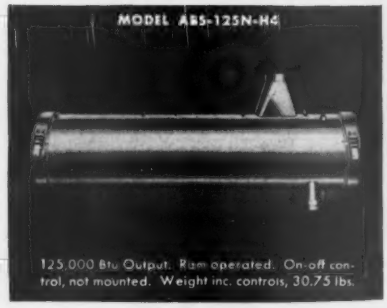
The flame resembles a tightly wound spiral and is stable at all altitudes. It sustains combustion under the most adverse conditions because it is whirled around itself, thus ignition is continuous and the process is self-piloting.



50,000 Btu Output. Ram operated in flight. Full capacity fan and motor for ground operation. Hi-low control. Weight inc. controls, 43.8 lbs.



100,000 Btu Output. Ram operated. Hi-low control, mounted. Spark coil box unmounted. Weight inc. controls, 28.1 lbs.



125,000 Btu Output. Ram operated. On-off control, not mounted. Weight inc. controls, 30.75 lbs.

SURFACE COMBUSTION

TOLEDO, OHIO

America's oldest and largest manufacturer of gas-fired industrial and domestic heating equipment, with more than 30 years' experience in combustion research, and in the application, control and transfer of heat.

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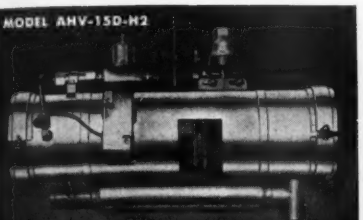
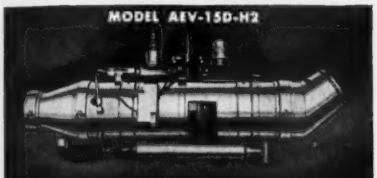
for Every Aircraft Need

MODEL AHV-15D-H2



15,000 Btu Output. Ram operated. On-off control, mounted. Weight inc. controls, 7.1 lbs.

MODEL AEV-15D-H2

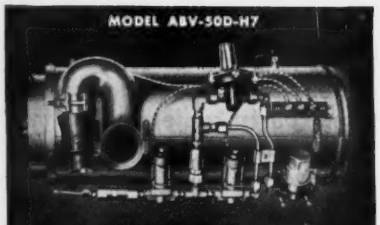


15,000 Btu Output. Ram operated. On-off control. Inlet and outlet adaptors. Controls mounted and wired. Weight as shown, 8.4 lbs.

MODEL ACV-40R-H2

40,000 Btu Output. Ram operated. On-off control, mounted. Weight inc. combustion air control, 15.2 lbs.

MODEL ABV-50D-H7



50,000 Btu Output. Ram operated. Hi-low control, mounted. Weight inc. controls, 16.6 lbs.

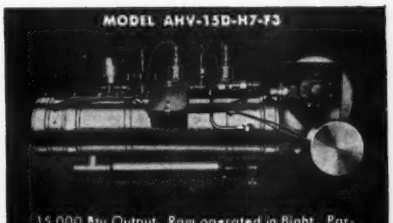
VAPORIZING (OR V-) TYPE HEATERS

The V- or vaporizing type heaters, shown on this page, are designed for operation on gravity fuel feed, normal low pressures, or for operation on high pressures. These heaters incorporate the principle of vaporizing the fuel prior to its diffusion with the combustion air stream, at which point it is ignited by a low voltage glow plug lighter. These heaters are suitable for installation on all types of airplanes.

PORTABLE HEATER

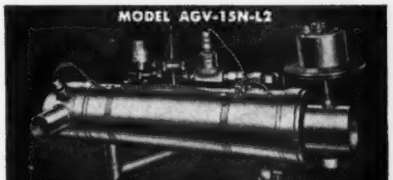
250,000 B.t.u. output. Model No. PBS-250-44, equipped with gasoline engine or electric motor. Adjustable louvered outlet shown. Flexible ducts also available.

MODEL AHV-15D-H7-F3



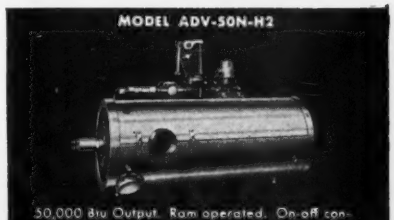
15,000 Btu Output. Ram operated in flight. Partial capacity fan and motor for ground operation. Hi-low control. Weight as shown, 16.1 lbs.

MODEL AGV-15N-L2



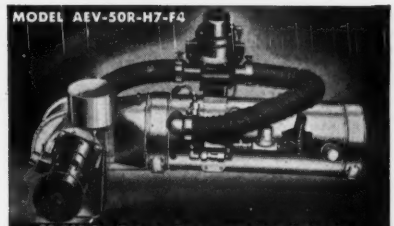
15,000 Btu Output. Ram operated. On-off control. Inlet and outlet adaptors. Weight as shown, 9.4 lbs.

MODEL ADV-50N-H2



50,000 Btu Output. Ram operated. On-off control. Lever regulator. Manual throttle control. Weight inc. controls, 14.2 lbs.

MODEL AEV-50R-H7-F4



50,000 Btu Output. Ram operated in flight. Full capacity fan and motor for ground operation. Hi-low control. Weight as shown, 40.8 lbs.

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Janitrol
AIRCRAFT HEATERS
with the whirling flame

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Wings for Our Ground Forces

The Douglas Skymaster is speeding the day when the enemy will nowhere be safe from our ground forces. These giant transports, with a range of over 2,500 miles and a ceiling of 26,000 feet, carry heavy loads of fighting men and materiel at 250 miles per hour.

This plane, with its loaded weight of 52,000 pounds, has to be exceptionally staunch. We are proud of our contribution to the stamina and performance of the Skymaster—super-tough drop forgings for the parts subjected to the abusive stresses of long flights with unprecedented loads.

In many history-making planes, the strength, toughness and durability of Kropp forgings have been transformed into greater speeds, longer ranges, heavier loads, higher altitudes and greater maneuverability.

The mass production of quality airframe drop forgings constitutes our entire output. The inquiries of plane and engine builders are solicited.

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From the Industry

Propellers for the Bell P-63

The new Bell Airacobra P-63 fighter plane just announced is reported to be equipped exclusively with automatic, constant-speed Aeroprop propellers. The P-63 also utilizes the hollow-shaft hub of the propeller for installation of its nose cannon.

Despite the fact that the propeller transmits increased engine power, the four-bladed model gives the new airplane 22 in. of ground clearance. The speed of the hydraulic pitch-changing mechanism of the propeller is stated to give the pilot automatic and almost instantaneous control of the plane in the most crucial air maneuvers.

The division's production during the remainder of 1944 will be devoted to the manufacture of three-, four-, and six-bladed propellers, the last of a dual-rotation design. All models are designed around basic Aeroproducts' principles of unit-construction and hollow, ribbed-steel blades. Aeroproducts Division, General Motors Corporation.

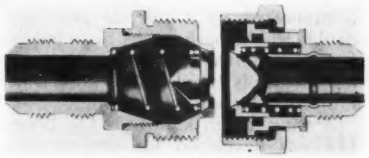
Four-Bladed Propellers for P-51 Mustang

A new contract to supply Aeroprop four-bladed, automatic, constant-speed propellers for the P-51 Mustang has been reported. While production of the division has been limited chiefly to the propellers for the Bell Airacobra P-39, the assignment for the P-51 is the forerunner of expanded use of the new propeller design. In addition to these two production models, it is stated that new Aeroprop designs have been assigned to every new fighter plane that the Army Air Forces has planned. Aeroproducts Division, General Motors Corporation.

Hydraulic "Fuse"

The Aeroquip Hydrofuse is designed to function in hydraulic systems in a manner comparable to a circuit breaker in an electrical system. It operates on the return-flow principle wherein any malfunction of the hydraulic system, such as a ruptured line, which causes a diminution of the return flow through the device, causes it to shut off and prevent waste of hydraulic fluid.

If a selector valve in a hydraulic system is opened the unit sends a sample of fluid through the lines; this starts operation of the selected actuator. The fluid returning from the actuator opens the valve and permits continued operation. However, if there is a broken line in the selected circuit or if a line is broken while the circuit is in operation, the "fuse" will prevent loss of more than a few cubic inches of fluid. After the selector valve is closed the Hydrofuse may be reset by either manual or hydraulic means, which will permit functioning of any circuit which is not damaged.



The Aeroquip self-sealing coupling.

The device weighs approximately 1.7 lbs. Ordinarily a single unit will protect the entire hydraulic distribution system in an airplane. Aeroquip Corporation, Jackson, Mich.

Self-Sealing Coupling

An improved self-sealing coupling, which allows disconnection and reconnection of hydraulic or other lines without loss of fluid or inclusion of air, has been announced. Seal is effected by an O-ring packing embedded in the recess of the coupling body. One-half of the coupling can be provided with a detachable mounting flange.

On connecting the coupling halves, the protruding portion of the left half makes contact with the sleeve of the other body. Simultaneously all air is expelled between the mating parts of the halves, thus preventing it from entering the system. Further movement of the union nut will move the valves until a position is reached allowing free passage of fluid. It is claimed that this coupling can be installed successfully in suction lines since there is almost no restriction when the device is completely coupled.

The equipment is made to conform with Specification AN-C-65. In order to make installation of the new improved design possible, a complete set of self-sealing couplings conforming with this specification has also been made available with AC-811-type end connections. Aeroquip Corporation, Jackson, Mich.

Employment of Veterans in East Coast Aircraft Plants

A report on the re-employment of World War II veterans by its member companies has been issued by the Aircraft War Production Council, East Coast, Inc. The report tells what has been done in this connection by Bell Aircraft Corporation, Chance Vought, Curtis-Wright, Eastern Aircraft, Fairchild Engine & Airplane Corporation, The Glenn L. Martin Company, and Republic Aviation Corporation. It also outlines Government regulations with regard to the re-employment of veterans, and cites a number of representative case histories of veterans who have been employed or re-employed by the various companies. These typify some of the problems that are encountered both by the employing companies and by the veterans in the process of adjustment to civilian jobs after war experience. Aircraft War Production Council, East Coast, Inc., New York.

Portable Steel Hangar

Simplicity of erection and saving of critical materials are among the advantages claimed for a new portable steel hangar building. It is stated to be capable of carrying a higher load per pound of steel than any other current design.

Two sizes of hangar have been built to date—one with an inside width of 152 ft. at the base and a height of 36 ft. 7 in.; the other with a width of 192 ft. and a height of 48 ft. The length may be any multiple of $17\frac{1}{2}$ ft.

The arches, assembled at ground level, are made up of pressed metal units bolted together into segments that are identical and interchangeable. These circular arch rings weigh a maximum of 3 and 7 tons and are hinged to a corrugated base plate. By means of two 40-ft. poles, two sheaves, and a winch truck, an arch ring can be raised within 15 min.

Space between the arches is covered with standard Steelox panels. These span from arch to arch, serving both as purlins and roofing. They are bolted to the top chord of the arches. These panels are the same as those that have been in use for frameless steel building construction. The ends of the hangar, including the doors, are built of Steelox panels. A new type of multiple-door section supported on a single rail at the bottom is a feature. The American Rolling Mill Company, Middletown, O.

To Build Helicopters

The formation of Bendix Helicopter Inc. has been announced as successor to Helicopters, Inc., organized by Vincent Bendix in 1943 to take over the development of a new type of helicopter.

The new helicopter is reported to incorporate original and exclusive principles of operation and performance. Three models are currently being designed in the company's development program. Included are: a two-passenger, 165-hp. helicopter with a top speed of 120 m.p.h.; a ten-passenger, one-ton helicopter of 600 hp., and a 20-passenger, two-ton air bus of 1,200 hp. Specifications of the two-passenger Model G are as follows: capacity, two passengers and baggage; maximum speed, 120 m.p.h.; cruising speed (using 75 per cent power), 100 m.p.h.; vertical climb (minimum), 480 ft. per min.; endurance at 75 per cent power, 3.25 hrs.; 165 hp.; engine speed, 2,100 r.p.m.; rotor speed, 300 r.p.m.; tip speed, 345 m.p.h.; rotor diameter, 32 ft.; useful load, 626 lbs.

Bendix Helicopter Inc. is not affiliated in any way with the Bendix Aviation Corporation. The company will license and manufacture in the United States and export to foreign countries. Officers are the following: Vincent Bendix, President; Claire L. Barnes and Martin Jensen, Vice-Presidents; James W. Garside, Treasurer; Charles L. MacDonald, Secretary. Bendix Helicopter Inc., New York.

Design Origin, Development, and Scope of Production of B-29 Superfortress

Certain details of the Boeing B-29 Superfortress, together with information about the manufacturing program and the history of the plane's development, have been revealed.

The Superfortress is one and one-half times the size of the Boeing Flying Fortress and its engines are nearly twice as powerful. It has a wing span of more than 141 ft., is nearly 100 ft. long, and has an overall height of more than 27 ft. It is described as long and cylindrical in shape, with slender tapering wings. The plane has a single fin and rudder closely resembling the dorsal fin that characterizes the Flying Fortress and Stratoliner. The weight of the plane is supported by a tricycle gear, with double wheels both on the main landing gear and at the nose. A distinguishing feature is the elongated nose, which projects well ahead of the wings.

A wing design known as the Boeing 117 was developed for this airplane. Flush-riveted and butt-jointed externally throughout, the plane design incorporates unusual nacelle design, enclosed turbosuperchargers, flush drains, vents, etc.

The control surfaces are actuated "direct" by the pilot. Research conducted by the late Edmund T. Allen and the Boeing aerodynamics unit resulted in control surfaces so closely balanced, both aerodynamically and statically, that no power or boost is required to move the controls of the plane. The designers had the benefit of the coordinated efforts of the Army Air Forces Matériel Command technicians and the combined experience of the Army Air Forces General Staff and Operating Commands.

Engines for the Superfortress were designed and are being built by the Wright Aeronautical Corporation. They are also being produced by the Dodge Division of Chrysler Corporation, whose plant at Chicago was especially built for this program. The engines, rated at 2,200 h.p. each, are 18-cylinder, radial, air-cooled Cyclones. The four in each Superfortress develop a maximum power twice the total of the B-17 engines. The propellers are four-bladed 16½-ft. Hamilton Standard units.

The airplane is armed with 0.50-cal. machine guns and a 20-mm. cannon. Details of the armament features, as well as specific performance of the plane, are withheld as restricted military information, but it is stated that the B-29 will have a range substantially greater than the maximum effective range of today's longest-range heavy bombers and it will carry sizable bomb loads for that distance.

The Boeing plant in Seattle is now in the process of conversion to production of the B-29. On completion of the conversion all Boeing facilities will be devoted exclusively to this type. Both Douglas Aircraft Company and Lockheed Aircraft Corporation Factory "A" in California will continue to build Flying Fortresses. Boeing Aircraft Company.

Flight-Test Recorder

An electronic flight-test recorder that records 144 points in testing aircraft in about the same number of seconds was recently exhibited at the Franklin Institute in Philadelphia.

In addition to the flight-test recorder, a public showing was given of the Disney animated films that depict the basic principles of the electronic automatic pilot.

Both exhibits were shown as part of an "Arts of Industrial Instrumentation" exposition. Approximately 100 photographs were displayed, most of which had to do with the part played by industrial instruments in war. One exhibit was a 19th-century pyrometer. The progress made in instrument construction since the antique device was produced was exemplified in an accompanying display of an electronic amplifier. Brown Instrument Company, Division Minneapolis-Honeywell Regulator Company.

Information About Cerium

Cerium is a metallic element of atomic number 58 and atomic weight 140. It is of steely gray appearance and has long been used as a basis metal for pyrophoric alloys. Various Cerium alloys have been developed on a commercial basis and are now available.

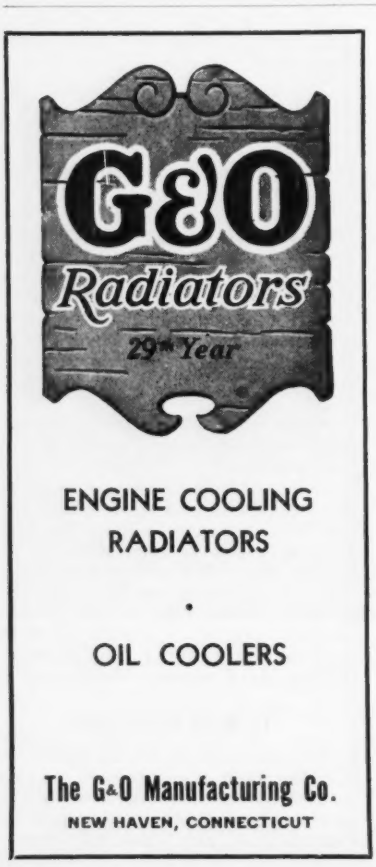
Some indicated applications include the following: Cerium alloy additions of less than one-half per cent in conjunction with manganese are stated to refine the grain of magnesium castings, increase hot strength, hardness, and corrosion resistance. Small additions of Cerium alloys are said to refine the grain and stabilize carbides and nitrides, improve the creep resistance, and to increase the oxidation resistance at elevated temperatures of stainless steels, electrical-resistance and heat-resistant alloys.

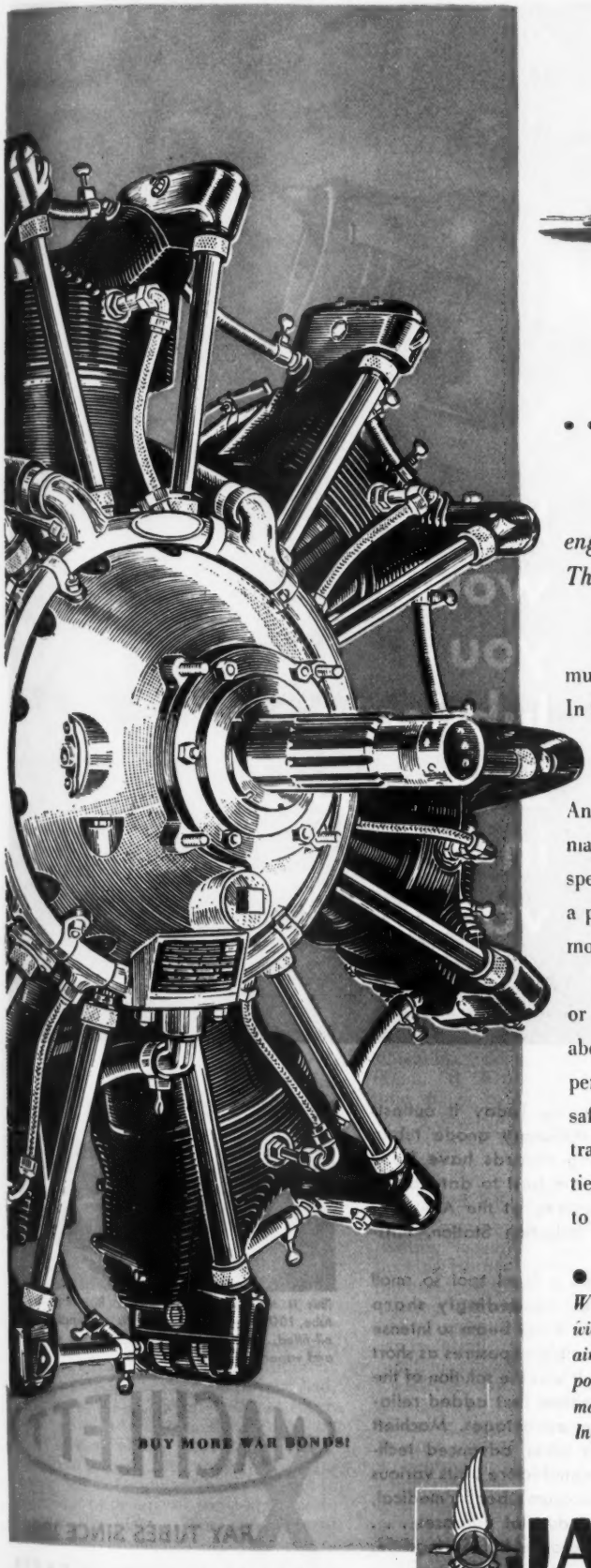
The film-forming properties that small additions of Cerium convey to bearing metals and alloys may be attributed to the formation of Cerium-rich compound films that resist seizure and reduce wear. As a deoxidant and grain refiner for tool steels, the alloy is indicated alone or in conjunction with other metals such as vanadium, boron, aluminum, and magnesium. The properties of Cerium suggest its use not only in welding electrodes, but in arcs and sparks where brightness, intensity, and stabilization are important. Cerium Metals Corporation, New York.

Survey of Postwar Aviation Market Prospects

A postwar survey reveals that a minimum of 100,000 persons now living in city areas want, or expect to own, their own private airplanes. These figures are based on a four months' survey made by the Research Department of Crowell-Collier Publishing Company. The study was made as a guide to postwar aviation markets among people in upper-income brackets in urban communities.

An additional 200,000 upper-income city dwellers said a plane was second on their list when and if available. The





Pedestrian

. . . but very pertinent!

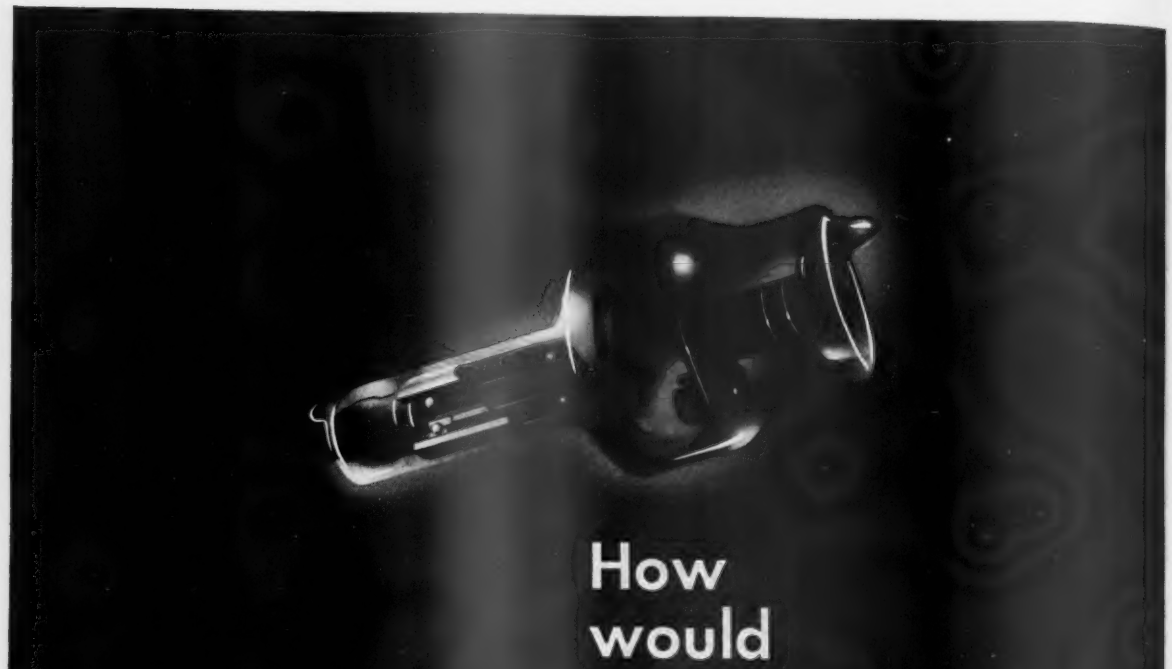
"Too bad," said a well meaning friend, "that your engines are used only in training and transport planes. They'd get a lot more publicity in combat ships."

MAYBE SO, but we're satisfied. Publicity doesn't prove much about a plane engine—but performance records do! In twin-engine trainers under hard student handling, these Jacobs engines take more take-offs and spend more time at full throttle than any engine in combat service . . . And then stand up for more than 1,000 hours between major overhauls—performance *three times* the original specification or expectation. That's air time enough to take a plane more than 150,000 miles. Ever hear of an automobile engine putting on so much mileage *between overhauls?*

To anybody who knows anything about plane engines, or aircraft operation . . . to anybody who knows anything about airline equipment or operating costs . . . Jacobs' performance records stand out like a house afire! Because safety, payload, maintenance costs, and profits in any air transport operation, feeder or through line, are pretty well tied up with the engine. And Jacobs engines are not going to lack either jobs or markets after the war.

● JACOBS AIRCRAFT ENGINE COMPANY *also manufactures Pratt & Whitney engines used by both the Army Air Forces and Navy in a wide variety of services . . . Largest manufacturer in the world of aircraft engines of medium power rating, Jacobs has in prospect postwar models of both higher and lower horsepower than those now made and interesting power applications for uses other than aviation. Inquiries are invited . . . Jacobs Aircraft Engine Co., Pottstown, Pa.*

JACOBS • **Pottstown, Pa.**



This is a cross-section of the Machlett Dynamax X-ray tube. The ball bearings support the anode, which rotates at 3000 r.p.m., and reaches a temperature of 1000° F. The entire structure is in a vacuum of about 10^{-6} mm. of mercury, or a billionth of an atmosphere.

Conventional lubricants cannot be used, because they would destroy the vacuum and the tube. Machlett's scientific studies showed that a very thin film of certain metals can act as lubricant. Pure silver was found most advantageous. An almost molecular-thin film of it is deposited upon the balls in a vacuum, by a unique method.

So successful was this technique that Machlett, five years ago, guaranteed its Dynamax rotating anode tube for 10,000 exposures. Today it outlasts conventional stationary anode tubes. Some amazing records have been made with it, the best to date being 272,610 exposures, at the Army Examining and Induction Station, Pittsburgh, Pa.

This tube has a focal spot so small as to produce exceedingly sharp pictures, and an X-ray beam so intense as to make possible exposures as short as 1/60th sec. It was the solution of the lubrication problem that added reliability to these advantages. Machlett employs many other advanced techniques in the manufacture of its various types of high-vacuum tubes for medical, scientific and industrial purposes . . . Machlett Laboratories, Inc., Springdale, Connecticut.

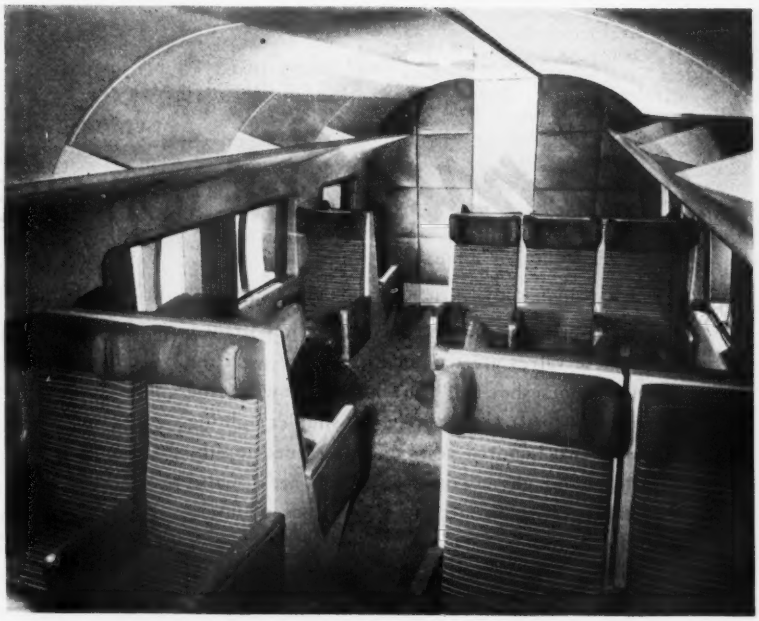
This is the Machlett Dynamax Rotating Anode tube, 100 kilovolts, 50 kilowatts, as supplied in an oil-filled, shockproof housing with air circulator and vapor-proof cable terminals.

MACHLETT
X-RAY TUBES SINCE 1898
TODAY THEIR LARGEST MAKER

total figure of 300,000 planes, according to the survey, was not to be regarded as a prediction of how many planes would be sold, but rather as a gauge to consumer desire.

Over and above the civilian market there is believed to be a definite market of Army and Navy fliers, 73 per cent of whom want to own planes when they return to civilian life. Another 12 per cent of Army and Navy pilots would like a plane if they could afford one. Only 15 per cent had no interest in owning a plane, although they now fly for the armed services. More than 500 pilots were interviewed during this portion of the survey. The survey revealed that most people wanted a four-seater plane, but 71 per cent would accept a two-seater if costs of the larger unit were prohibitive.

Regarding the use of air lines after the war, the survey indicated that 62 per cent of the women questioned expected to use the facilities of air lines. The figure for the men was 68 per cent. More than 65 per cent of those surveyed would be definitely interested in a round-trip flight to Europe if the fare were not over $200. Civil Air Patrol League, Inc., New York.



The club-car arrangement of seats in the Consolidated Vultee Model 39 Liberator Liner. The carpet, of special weave, weighs only 2 oz. per sq.ft.

Model 39 Liberator Liner

Consolidated Vultee Aircraft Corporation's 48-passenger Model 39, to be known as the Liberator Liner, combines a spacious, specially designed fuselage with the B-24 bomber's wings, engines, and landing-gear components.

Intended for normal long-range operations up to 2,500 miles, the Model 39 will carry 48 passengers, baggage, and 1,200 lbs. of mail as a day plane; 24 passengers as a sleeper; or 12,000 lbs. of pay load as a cargo transport. Its maximum range is 4,000 miles.

Top speed is 270 m.p.h. and normal cruising speed is at 240 m.p.h. at 60 per cent power. The wing span is 110 ft. and the length of the fuselage is 90 ft., with a maximum diameter of 10 ft. 6 in.

The interior of the plane, designed by Henry Dreyfuss, of New York, emphasizes passenger comfort. For passengers who have business to transact a private office is available. At night the chairs of unusual design convert into roomy berths. Polaroid windows permit regulation of outside light. Dressing rooms are equipped with full-length plastic mirrors. Seats are equipped with individual reading lights and "pillow" radios inaudible to companions.

In order to fit the plane for any type of commercial service, four different seating arrangements may be installed, as follows: (1) The conventional coach plan, with a center aisle flanked by pairs of easy chairs. Seats are slightly canted to provide better view out of windows; (2) Seats placed back-to-back in pairs and in groups of three and one to stagger the aisle. This arrangement provides a club car effect; (3) Pairs of seats on either side of the aisle, all facing forward, which convert into lower berths at night. Upper berths swing out from the ceiling as on Pullmans; (4) Conventional Pullman-car berth arrangement, but slightly larger than in the standard train sleeper. Baggage compartments are located amidships and in the tail. Additional lounge space is provided in the after section adjacent to the galley.

Specifications of the Model 39 follow: type, long-range commercial transport for day and night operation; engines, four 1,100-hp. Pratt & Whitney; wing span, 110 ft.; fuselage length, 90 ft.; maximum fuselage diameter, 10 ft. 6 in.; passenger capacity, 48–52 (24 as a sleeper plane); basic gross weight, 56,000 lbs.; provisional gross weight, 62,000 to 64,000 lbs.; cargo pay load, 12,000 lbs.; normal cruising speed, 240 m.p.h. (at 60 per cent power); maximum range, more than 4,000 miles (at 200 m.p.h.); stalling speed, 88 m.p.h. Consolidated Vultee Aircraft Corporation.

"Bucking Bar" Riveting Assembly

The development of a new type of riveting assembly involves a special bucking bar setup that permits greatly increased output, facilitates uniform riveting, and reduces the amount of man power required to build airplanes. It can be installed in a jig or frame so as to function automatically, or it can be wielded manually so as to increase the efficiency of the individual workman. Claiming that the new assembly will produce savings in time and materials amounting to at least 25 per cent, the company plans to make the assembly available to other manufacturers as soon as adequate facilities are developed. Consolidated Vultee Aircraft Corporation.

Master Tooling Dock

A "master tooling dock" has been developed by a consulting engineer for Consolidated Vultee. This is a three-dimensional position device, used in constructing the large tools required in aircraft work. It is credited with having effected savings for the company in time and materials amounting to more than 50 per cent. It is claimed to be more accurate than previously used devices and methods, and enables unskilled workmen to accomplish jobs that formerly necessitated the services of veteran toolmakers.

This device facilitates toolmaking by reducing the process of finding three-dimensional locations to a series of simple and precise operations. Location of any point within its boundaries to a tolerance of 0.001 in., is accomplished by means of longitudinal, vertical, and transverse "straight edges" moving within a rigid frame. Consolidated Vultee Aircraft Corporation.

First Twin-Engined Type with Four-Bladed Propellers

The Northrop P-61 Black Widow is reported to be the first twin-engined fighter yet announced to have four-blade propellers. The twin four-bladed automatic constant-speed Curtiss electric propellers for the Black Widow are 12 ft. 2 in. in di meter. Each has hollow-steel Curtiss blades that are stated to provide a material weight-saving over comparable solid aluminum-alloy blade propellers. The propeller also is equipped for fast full feathering, enabling the plane to fly on one engine in an emergency. The electric propellers are mounted on two Pratt & Whitney 2,000-hp. engines. Curtiss-Wright Corporation.

Capsules OF LIFE OR DEATH!

Valves—that's what these are—and their innocent appearance serves only to conceal their importance. For these valves are to modern warfare what the famous "horseshoe nail" (for the want of which the battle was lost!) stood for in the simpler fighting days of two hundred years ago. Designed for the control of oil, gas and other fluids, they are in active wartime service in aircraft of all types on every fighting front.

The four Weatherhead plants have long been fully engaged in making vital parts for the nation's war machines at the rate of more than a million a day—and are prepared to make the same gigantic contribution to the peacetime needs of the nation!

Look Ahead with

Weatherhead

THE WEATHERHEAD COMPANY, CLEVELAND, OHIO

Manufacturers of vital parts for the automotive, aviation, refrigeration and other key industries.

Plants: Cleveland, Columbia City, Ind., Los Angeles
Canada—St. Thomas, Ontario

FREE: *Write on company letterhead for "Seeds of Industry"—a history of The Weatherhead Company, its many facilities and diversified products.*

"C" Clamp Holds Double Angle Shapes

An improved toggle-action "C" clamp is featured by two adjustable clamping spindles to grip the work at any selected point. This permits clamping over double angles and other irregular shapes. The clamping gap is adjustable to any thickness within the clamp range. Each spindle is locked into place and remains at that exact setting until manually re-adjusted. Quick clamping and release are effected by toggle action. Upon release the entire upper portion of the clamp swings clear of the work. By changing the location of retaining bolts, the toggle handle may be adjusted to either a straight-out or downward position when the clamp is locked.

The body of the clamp is a malleable-iron casting. The threaded spindles are copper-coated to guard against welding spatter. The links and handle are plated to resist corrosion. The clamp is a 6-in. size, with 3-in. throat. It is listed as De-Sta-Co Model No. 480. Detroit Stamping Company, Detroit.

Plastic Linings for Anodizing Tanks

Resistance of Lucite methyl methacrylate resin to attack by acids is the basis for a new use of the plastic as the lining for 28,000-gal. tanks holding chromic and sulphuric acid anodizing solutions in the treatment of aluminum-alloy aircraft parts.

Sheets of Lucite are used to line the tanks in which the aluminum parts are given surface-oxidizing treatment at the Curtiss-Wright Corporation plant at Columbus, O. Use of the plastic is reported to have extended the life of the tanks indefinitely. The plastic is not affected by sudden temperature changes nor by the 15 per cent chromic acid solution.

The linings were installed as the result of the company's experience with Lucite tubes as the insulation for parts while exposed to the electrolytic action of the acid baths, in which use the plastic was credited with doubling the output of the anodizing equipment at the plant. E. I. du Pont de Nemours and Company (Inc.).

Plastic Parts for Aircraft Instruments

Introduction of Lucite methyl methacrylate resin for parts of aircraft inclinometers and vertical-speed indicators for the Army Air Forces is reported to have resulted in gains in accuracy and reductions in the cost of the instruments.

The Cruver Manufacturing Company, of Chicago, found that use of du Pont Lucite had reduced breakage and cut costs by 50 cents per unit on the manufacture of the inclinometer. Savings on the vertical speed indicator may run as high as $40 per unit, it is stated.

Accuracy is essential in molding plastic parts for these delicate devices. A speck of dust on the floating glass ball, an important moving part of the inclinometer, can seriously impair the accuracy of the instrument's operation.

Releases are printed as received from companies and other aeronautical organizations and the responsibility for the accuracy of all statements is therefore not assumed by the Aeronautical Engineering Review.

Sections $^{5}/_{1,000}$ in. thick and tolerances of $^{5}/_{10,000}$ in. are required for parts of the vertical-speed indicators.

The inclinometer is molded in one piece. The vertical-speed indicator is assembled from four separate plastic parts, including an indicator body molded of Lucite. Two long, tapered indicating tubes are molded as integral parts of the body. The indicator is being used at present in gliders, training planes, and balloons. E. I. du Pont de Nemours and Company (Inc.).

Electric Actuators

Eclipse Electric Actuators are designed for applications requiring electric-motor-driven gear-reduction units to retract and lower landing gear, open and close bomb bay doors, control wing flaps and other similar functions. The actuators are available in concentric and right-angle design to provide maximum compactness and clearance, depending on the characteristics of the installation under consideration.

Design features include an automatic compensating torque-limiting device in the form of a multi-ply disc clutch that protects the reduction gearing and motor in the event of undue loading. A special magnetic equalizing clutch prevents overrunning and jamming. This feature also facilitates hand operation on models so equipped by eliminating the resistance of the gear train and motor.

Explosion-proof motors, available in certain models, are completely enclosed against explosive vapors, as well as mud and dirt. Motors are available for 24-volt d.c. operation. Eclipse-Pioneer Division, Bendix Aviation Corporation.

Control for Capacitor Welders

The Trignitrol is a silent, electronic switch designed to supersede mechanical switching on capacitor welders. It discharges the condenser bank through the welding transformer. This instantaneous peaked discharge is reported to weld with minimum damage to metal grain structure and without burning of surrounding metal, while the total capacitance required is substantially reduced.

The device utilizes the trigniton, a new mercury-pool conduction tube, fired capacitively by a low-power trigger circuit. The control circuit must be reopened before the unit will recycle, but speed of operation is limited only by the condenser recharging intervals.

Only four simple connections are required for immediate installation. Power supply is standard 110- or 220-volt, 60 cycle a.c. Electronic Power Company, Inc., New York.

Salvaging Zinc Die Castings

It is reported that damaged zinc-base die castings can be reclaimed more easily with an improved gas welding. EutecRod 195 has a lower melting point and a still lower bonding temperature than the original alloy, which make it easier to apply without danger of damaging the parent metal. The improved rod is also easier to build up with, has greater tensile strength, and matches the hardness of the die castings. Eutectic Welding Alloys Company, New York.

Sextant for Aircraft Use

Simplicity is a characteristic of the A-10 aircraft sextant. Besides the field prism, mounted on a sector gear, the fixed prism, bubble chamber, and objective lens assembly, the parts of the sextant include a marker, recording disc, counter, and control knob. When the navigator holds the sextant to his eye and aims for Saturn, the planet's rays shine through the two prisms and are reflected to the parallel eyepiece where the navigator watches. A pinhead of light shows in the sextant and the navigator must make this pinhead align with a bubble that always remains horizontal. Since the true horizon is often out of sight when a bomber is aloft, the bubble takes its place. The objective lens and its reflector perform jointly to superimpose the bubble on Saturn's reflection. Thus the angle of altitude of Saturn in relation to the true horizon is found. By twisting the control knob, the navigator may shrink or expand the bubble, which is inside a bubble chamber.

Used to sight the sun by day and the planets or stars by night, the sextant needs illumination for night work. This is provided by a pilot light, Lucite bubble-chamber light ring, and a pocket-size battery assembly.

The control knob also regulates the revolving of the field prism. A series of stop washers in the knob prevents the prism from being rotated through an arc whose deflection is more than 93°.

An electrical marker assembly records the navigator's readings. While he works the sextant, he presses a trigger at intervals, which operates a timer-switch to energize a marker. The marker acts as an electric solenoid. When the solenoid's circuit is closed, it controls a lever, pressing a point made of lead onto a paper to record what the navigator finds. Fairchild Camera and Instrument Corporation, New York.

Forming Roll Designed for Template Following

A new model forming roll is designed for forming leading-edge skins or fuse-

Fast, high-flying B-29 Superfortresses like this are now carrying the air war to the heart of the Japanese empire.

Crew of new B-29 gain better protection during pressurized high altitude flying

WITH ENCLOSURES OF LAMINATED "LUCITE"-"BUTACITE"!

CREWS of the Boeing B-29 Superfortresses fly long distances at heights of 30,000 feet and in more comfort and warmth because of the superbomber's pressurized cabin.

Unprecedented in military planes, the pressurized cabin allows temperatures to be maintained at normal or near-normal—no matter how high the altitude.

Top and side turrets of Du Pont laminated "Lucite"-"Butacite" afford clear vision for the crew. Also the possibility of a major rupture by flak or bullets is eliminated, due to tendency of the interlayer of "Butacite" to seal a bullet hole or limit it to a small area even under pressure.

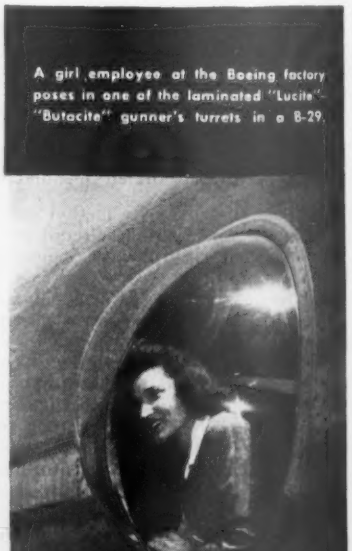
In the event of penetration, the hole is confined to the area of the actual point of impact, and it can be easily and quickly patched in flight with a prepared disc of "Butacite."

In addition to these advantages, the light weight and ease of forming and mounting make enclosures of laminated "Lucite" methyl methacrylate resin and "Butacite" polyvinyl butyral resin sheeting applicable to a wide variety of aircraft uses.

FULL FACTS: A new 28-page "Progress Report" on this laminate gives technical information on proof tests, property graphs, and application. For the designing, specification, forming or fabrication of transparent plane enclosures, address E. I. du Pont de Nemours & Co. (Inc.), Plastics Department, Arlington, N. J., on your business letterhead for a free copy. Canadians write to Canadian Industries, Ltd., Box 10, Montreal.

• • •

A girl employee at the Boeing factory poses in one of the laminated "Lucite"-"Butacite" gunner's turrets in a B-29.



INVEST IN VICTORY—BUY WAR BONDS

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DU PONT PLASTICS

Better Things for Better Living . . . *Through Chemistry*

lage skins to the desired contour in one pass through the machine. Flat aluminum-alloy sheets are fed into one side of the machine, and the finished curved parts come out of the other side. This procedure requires no particular training, and an unskilled worker can operate the machine efficiently. The former process of changing dial settings and reversing the rolls several times is eliminated. The builder states that production with the new design is six to ten times faster than that of earlier models.

The movement of the upper roll is controlled by two templates, one on each end of the machine. As the part feeds through the rolls these templates raise or lower each end of the upper roll as required, to form the proper contour. Hydraulic pressure is used to hold the template followers against the templates and also to raise the upper roll for inserting the sheet to be formed. Adjustable stops are provided for locating sheets in their proper position in the rolls.

The features of the builder's preceding forming rolls, such as minimum nose radius and tapered sections, are retained. The new model will form aluminum-alloy sheets $^1/_{16}$ in. thick and 15 ft. long, to a minimum $1^1/_4$-in. radius. The machine was designed by Paragon Research, Inc., Farnham Manufacturing Company, Buffalo, N.Y.

Bullet-Sealing Oil Tanks

Bullet-sealing oil tanks have been a greater problem than similar tanks for gasoline because oil is heavier than gasoline. Because oil tanks are smaller than those required for gasoline, the impact of a bullet on the oil tanks causes an extremely high hydraulic ram or shock.

Aluminum shells were tried on the tanks to keep them from being smashed out of shape when bullets hit, but the hydraulic ram of the bullet distorted the shells. The metal shells then failed to support the oil tanks, and the surfaces of the tanks did not line up properly to seal the bullet holes. Another fault was that the jagged or "flowered" petals of metal which lined the edges of a bullet hole often held the tank open and allowed the oil to escape.

Firestone engineers have now created a nonmetallic shell that is reported to react satisfactorily to gunfire and at the same time to withstand reasonably high temperatures for a prolonged period. This was done by impregnating plies of glass fabric with a resin called Velite, which the company developed. The result is a smooth supporting material that neither shatters nor "flowers," nor is it distorted when struck by a bullet. Instead, the bullet merely leaves a thin slit in the material.

The oil tanks and the shell are cured as one unit, and a rigid structure is obtained. The sealing portion of the tank is supported after gunfire, and oil leakage is cut to the lowest point yet obtained. Firestone Tire & Rubber Company.

Totalizing Contents of Aircraft Fuel Tanks

Although heretofore the application of the totalizing system in aircraft fuel tanks has been limited to three transmitters per installation, the use of this system for a larger number of transmitters and tanks has been found to be practical. The method of totalizing the contents of several fuel tanks as a single indication on a remote-indicating instrument involves two classifications of totalizing, designated as sequence totalizing and nonsequence totalizing.

Sequence totalizing is used where the sequence of use of the fuel is established by the design of the fuel system. Examples of this use include a single wing tank that requires two or more transmitters to register its contents because of the large dihedral. Permanently interconnected tanks also illustrate this function.

Nonsequence totalizing involves the use of the fuel in several tanks in any conceivable sequence of use. Tanks in this system are not permanently interconnected, and fuel to the engines may be withdrawn from any or all tanks at the discretion of the pilot. General Electric Company.

Electronic Control with Automatic Compensation for Voltage Variations

The CR7503-D157 voltage regulator, for use with most G-E resistance-welding controls that include the phase-shift method of heat control, is designed to regulate the welding current automatically. The current is held constant regardless of line-voltage variations of as much as +10 or −20 per cent.

The regulator consists of a resistor circuit connected to the power line that supplies the welding machine, and an electronic circuit. When the regulator is in use, this electronic circuit functions not only to hold the average voltage of the resistor current constant but also changes, electronically, the phase-control voltages of the main welding-control panel. If the line voltage drops, which normally would cause corresponding variation in the current through the welding transformer and the voltage of the resistor circuit, the regulator advances the phase-control voltages, thereby automatically holding the welding current constant within close limits. The regulator can be used on welding circuits whose power factor is from 20 to 70 per cent, and can be operated from 230/460/575 volts on a 50/60-cycle power supply. It operates whether or not the welding current is flowing. This feature enables it to compensate for a sudden voltage drop in less than 3 cycles, with approximately 75 per cent of the compensation taking place during the first cycle. General Electric Company.

Rubber Mounting for Engines of the B-17

A new rubber mounting for the engines of the B-17 bomber is expected to smooth the operation of the plane, decrease strain on structural parts, lessen the nervous tension and fatigue of pilots and crew, and increase the accuracy of precision instruments, resulting in more accurate bombing and gunfire.

The new mount has two main parts. The first is a collar, lined with a rubber bushing. This collar is attached to lugs welded to the mounting ring and has a socket at right angles to the collar itself. The other half of the mounting, a small unit attached to the engine, ends in a ball that fits into this socket.

Vibrations developing in the engine are isolated by two features of the mounting, the ball and socket joint just described, and the rubber bushing in the collar. The ball and socket feature produces a rocking motion in the rubber bushing.

It is indicated that the new mounting is equally applicable to all types of planes and that its successful use on the Flying Fortress will lead to development of models for all types of planes. Goodyear Tire & Rubber Company.

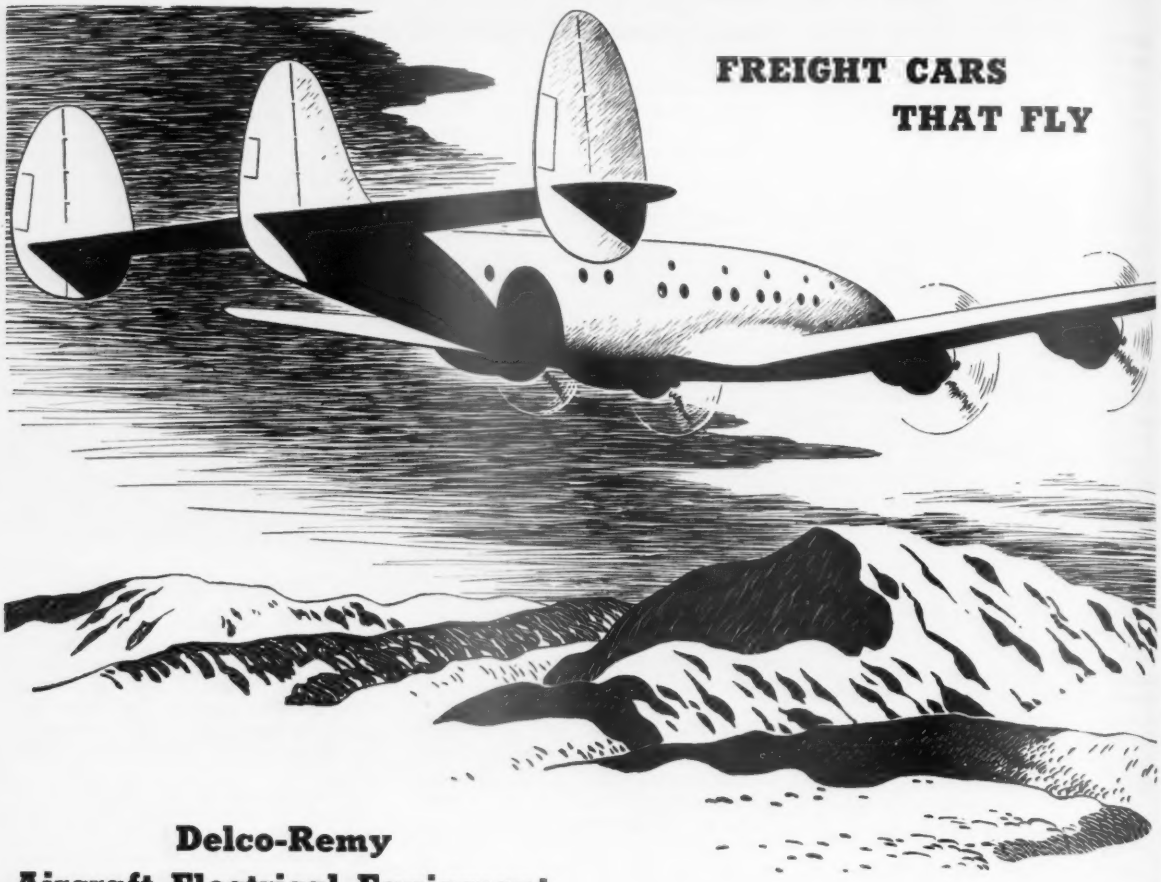
"Stropping" Propeller Blades

Propeller blades are "stropped" to an accuracy of $^1/_{10,000}$ in. by means of a new 5-ton machine whose belt operates at a surface speed of 5,000 ft. per min. The machine, called a continuous strip grinding machine, is manufactured by the Murray-Way Corporation of Detroit.

The efficiency of the new machine is reported to reduce greatly the time and cost of processing a blade. Exact time comparisons cannot be made because of the many different blade designs and sizes and varying times of processing, but under the least favorable conditions the stropping machine is said to accomplish its task in less than 50 per cent of the time usually required.

The machine is one of the few sanding grinders in existence capable of grinding a variable surface, a necessity in finishing propeller blades that vary in width,

Lengthwise view of a new propeller blade shaper that grinds and polishes Duralumin blades by a strop, or continuous belt, which has a surface speed of 5,000 ft. per min. It grinds to a precision of $^1/_{10,000}$ in. This new machine, shown in the Rhode Island plant of Hamilton Standard Propellers Division, United Aircraft Corporation, was designed at Hamilton Standard and is manufactured by the Murray-Way Corporation of Detroit.



Delco-Remy
Aircraft Electrical Equipment

In tomorrow's chapter of man's endeavor to utilize more fully the world's natural resources, air transportation will provide a working force of unprecedented usefulness. "Freight cars that fly" will carry men and machinery into undeveloped regions, and haul away nature's rich yields. ¶ Dependability of aircraft will be of fundamental importance, and it is in this respect that Delco-Remy aircraft electrical equipment will find wide usage. Today, great numbers of bombers, fighter planes and transports depend on Delco-Remy equipment. More than half of Delco-Remy's facilities are now engaged in manufacturing aircraft electrical units, precision parts and products for the industry. ¶This broad background of experience in the design and manufacture of dependable electrical equipment will serve well in the post-war advance of new frontiers.

ARMY E NAVY

DELCO-REMY

DO MORE THAN BEFORE...BUY MORE WAR BONDS

DIVISION, GENERAL MOTORS CORPORATION

thickness, and angle throughout their length.

The strop, or continuous strip grinder, grinds longitudinally with the blade, running over and being guided by a forming drum synchronized with a table moving lengthwise through the rectangular frame of the machine. The drum, suspended above the blade, governs the pattern that is ground. A different drum is used for each blade design. Both the face and back, or camber, of the blade are ground to accurate dimensions by duplication from the contours of the drums, a different drum being used for each side of the blade.

Duralumin forgings to be ground are locked on ten adjustable pins of a cradle that is mounted on the movable table. The cradle can be twisted or tilted from side to side so that the blade can be ground at desired angles. Butt ends of the blade are held snug on a tapered arbor against a plate that is part of the cradle.

A hydraulic cylinder actuates the lengthwise movement of the table, which usually feeds at about 10 ft. per min. This feed speed is controllable and varies with blades of different sizes. Movement of the cradle is by means of guide rolls, linked with the drum, which run along steel tracks on the sides of the cradle. The pitch of the cradle is thereby actuated so that the blade surfaces are kept parallel to the forming drum and ground at the proper angle.

The forming drum is separated from contact with the blade only by the strop or continuous belt. The drum, which may also be considered as a rotating cam, is synchronized to the table by a rack on the table and a pinion on the cam. The drum may be raised or lowered so that the depth of the grind made by the strop is regulated to $^1/_{10,000}$ in. Each complete revolution of the feed-control hand wheel compensates for 0.030 in. of stock removal from the blade forging.

The machine first rough-grinds the face of the blade, then the camber, after which it similarly finish-grinds both sides using a strop of finer grit. After processing through the machine a blade has only to be hand-polished with a disc from the 24-in. mark to the shank before it is ready for finish-polishing and final balance. The stropping machine is intended to provide accuracy and to eliminate much of the hand work involved in the grinding, facing, and finishing of the semifinished blade forgings. An important feature of the machine is that it can cut its own forming drums. This is done by simply reversing the surfaces of the abrasive belt and using a master blade as a model. Hamilton Standard Propellers Division, United Aircraft Corporation.

Blind Rivet for Emergency Repair Work

A new blind rivet and rivet-driving hand gun can be used for emergency repair work. The rivet is of a universal type in that one grip length will suffice for any combination of sheet thicknesses from 0.050 to 0.300 in. The hand gun weighs less than 2 lbs. and is capable of exerting a pulling force of 1,000 lbs.

The new rivet differs from the standard blind rivets manufactured by the maker in that the method of driving a collar to lock the pin securely in the sleeve has been eliminated. Another difference is that the new rivet forms a tulip blind head, whereas the standard rivet forms a bulbed head. The hole-filling action of the repair rivet does, however, anchor the pin in the sleeve by friction. Because of the value of simplicity in the case of emergency repair work, the features of the lock and bulbed head are considered secondary.

The hand gun, which is especially designed for field repairs, will drive $^1/_8$-, $^5/_{32}$-, and $^3/_{16}$-in. diameter rivets in either brazier or countersunk types without any change or additional accessories. In addition to emergency field repairs, this rivet is recommended by the company for occasional repair work necessitated during production operations. It eliminates the need for setting up air-operated equipment. Huck Manufacturing Company, Detroit.

How Synthetic Rubber Is Used in Typical Four-Engined Bomber

An indication of the total volume of synthetic rubber used in production of modern warplanes is contained in figures showing the amount of that material required for each four-engined bomber.

A four-engined bombing plane of the type in current use requires approximately 1 ton of compound synthetic rubber, involving 800 to 1,000 lbs. of the crude material. Of this total, probably 20 per cent is represented by the linings of the bullet-sealing fuel cells, which are made from an oil-resistant synthetic rubber. The actual sealant in the tank wall is made of either natural or an oil-soluble synthetic rubber. Some of the fuel cells also have an outer jacket of synthetic rubber for protective purposes, and synthetic-rubber cement is used not only in the original fabrication but also in repair work.

Hard synthetic rubber sponge is used to fill in void spaces in wings to preclude the possibility of gasoline accumulating from slow leaks and forming a fire hazard. The sponge does not absorb the gasoline since each of the small cells in the sponge is totally enclosed by a film of hard, gasoline-resistant synthetic rubber. This synthetic-rubber sponge is also one of the lightest materials ever made, weighing less than 5 lbs. per cu. ft.

Other somewhat similar applications that require oil-resistant synthetic rubber are bullet-sealing fuel hose, oil hose, and hydraulic hose for various controls. The liquids used have little effect on oil-resistant synthetic rubber. This resistance to the fluid used in hydraulic control systems explains why synthetic rubber is also employed in accumulator bags, of which each four-engined bomber has several, including controls for fuel pressure, oil pressure, brakes, propeller pitch, landing gear, and similar applications.

Other uses requiring the oil-resistant type of synthetic rubber are diaphragms for carburetors, fuel gauges, and various fuel-system and control-system valves. Gaskets, packings, and seals for these items, as well as for fuel pumps and oil pumps, call for the use of oil-resistant synthetic rubber.

In connection with deicing equipment, a special sunlight-resistant compound is used as a veneer on the expanders. Expandable protective sleeves for landing gear and similar mechanisms also are made from oil- and sunlight-resistant synthetic rubber. The oil-resistant product is used for the covering of ignition cables, while other types of synthetic rubber are employed for the actual insulation of wiring and other electrical equipment. Also worthy of mention are the smaller items, such as line supports, clips, and grommets, of which thousands are used on a large bomber. These parts are generally manufactured from an oil- and sunlight-resistant synthetic rubber to insure long life and trouble-free service.

Practically all of the items mentioned are those involving applications where natural rubber would be either a poor substitute or could not be used at all because it would be unfavorably affected by oil, gasoline, heat, sunlight, or normal aging. The figures given are exclusive of any use of synthetic rubber for airplane tires. If synthetic rubber tires were included in the weights given, the total amount of synthetic rubber in the plane would be greater by several hundred pounds. Hycar Chemical Company, Akron, O.

"In Service" Training Courses

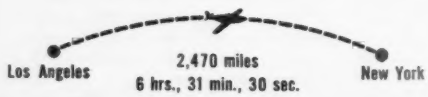
The Industrial Service Group, a special committee of faculty personnel, has been appointed at Illinois Institute of Technology. Its purpose is to arrange for "in service" courses at industrial plants for training workers. The employees who take the course pay no tuition, nor does the company that employs them. Costs of the training are paid by the U.S. Office of Education, through its Engineering, Science, and Management War Training Program.

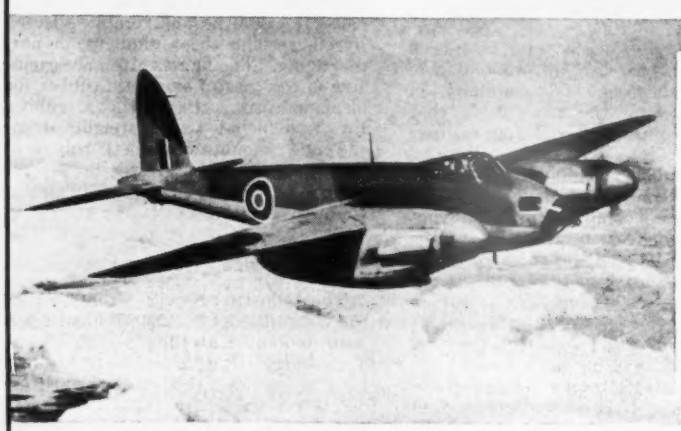
The committee keeps in constant touch with war industries in the Chicago area. To it are referred all the requests for information regarding training. If a company desires a course not being offered at the time, the committee takes steps to set it up. The Industrial Service Group also tries to maintain close contact with war industries in the Chicago area so as to anticipate the need for upgrading of personnel, perhaps even before executives are aware of the need, and to call this to their attention as indicating a need for an "in service" war training course. The first air transport company to utilize these facilities was Braniff Airways, Inc., for which a course in aircraft electrical systems has been established. The employees form classes when they finish their day's work, going to school five times a week, for 3 weeks. They volun-

TWO RECORD-BREAKERS...

and PACKARD-BUILT ENGINES powered them both!

May 12—Mustang fighter breaks transcontinental speed record





May 13—Mosquito bomber breaks transatlantic speed record

Two world speed records shattered, within the space of two days!

And both records were broken by war planes powered by Packard-built Rolls-Royce aircraft engines.

An Army Air Forces colonel set the new speed record for transcontinental flight in a North American P-51 "Mustang" fighter.

A ferry pilot of the R.A.F. established the new transatlantic speed record, crossing the ocean in a de-Havilland "Mosquito."

These records were made possible because pilots, planes and powerplants all did their part, functioning perfectly all the way.

We're gratified, naturally, that Packard-built engines took part in these record-breaking flights, and measured up to the high standards set by the pilots and the planes they flew.

But there's a still deeper satisfaction in knowing that *every fighting engine* we build may shorten the war by a week, a day, or an hour!

★ ASK THE MAN WHO OWNS ONE ★

tarily attend the classes on their own time. The three instructors for the course are all engineers with the Dallas office of Braniff Airways.

Since the program began early last fall, 78 industries, including Braniff Airways, have had Illinois Tech courses running. Currently, there are 24 companies with "in plant" courses in session. The courses include a wide range of subjects, from industrial management for foremen and electrical engineering to safety and plastics. In the aircraft electrical systems course, the Braniff employees are learning about the theory and operation of electrical equipment on aircraft. Illinois Institute of Technology, Chicago.

Automatic Pilot for Gliders

The automatic pilot for Army gliders is an adaptation of the automatic pilot manufactured for military airplanes. By the use of the device the glider can be set to follow the tow plane at a given altitude on a true course. This means that gliders hereafter may be flown in weather that formerly grounded the gliders, since it was necessary for the glider pilot to be able to see the tow plane.

The instrument in the glider is similar in appearance to the corresponding instrument for an airplane. In the glider a small air-driven propeller furnishes power for the hydraulic and vacuum pumps that operate the gyro units, and these in turn operate the controls of the motorless plane.

The glider branch experimental laboratory of the A.A.F. at Wright Field has developed the application of the automatic pilot to gliders. After months of study and tests the Jack & Heintz experimental units were approved and put into production. Jack & Heintz, Inc., Cleveland.

Carbide Gauge Blocks

Carbide gauge blocks, offered in sets, are made of tungsten carbide and are packed in durable, hinged wooden cases. Three all-carbide sets are available, and one set of 81 steel blocks has two 0.050-in. tungsten carbide wear blocks. The Jansson ten-block carbide set ranges in size from 0.050 to 0.0509 in. in steps of 0.0001 in. The two smaller sets are intended primarily to be used as wear blocks with steel gauge blocks. One contains two 0.050-in. blocks; the other contains two 0.100-in. blocks. Jansson Gage Company, Detroit.

"Fastop" Clutch and "Rota-Brake"

The Fastop clutch for motor-operated aircraft devices releases the motor rotor from the load when the circuit is de-energized. The rotor is allowed to decelerate naturally, while the mechanism that carries or operates the load stops instantly. The element of time involved in this disengagement between the rotor and the output shaft is about $^1/_{50}$ sec.

The principle of this instantaneous stoppage for the load involves an operating solenoid connected in series with the motor. There are two solid metal discs. One is connected directly with the rotor, called the drive disc. The other is connected with the output shaft and is called the driven disc. The driven disc is solid, but the rim of the drive disc is separated from its center portion by a nonmagnetic metal. In this way, north and south magnetic poles are formed when the motor is energized and the drive disc becomes a magnet. When energized, the driven disc is attracted to the driver and immediately starts to revolve at the same speed as the motor. In a de-energized position, the two discs are about 0.010 in. apart. When energized they adhere tightly.

The output shaft contains a small spring that draws the driven disc away from the driver at the very instant the current is shut off, snapping it back against a cork face that serves as a braking surface. In an energized position sufficient magnetic flux is produced to hold the two discs together without slippage for slightly more than the maximum load for which the particular motor is designed. However, should a jam develop in the device, thereby exerting too heavy a load, the clutch will slip. This safety feature is intended to prevent damaged gears and gear housing. Still another safety feature is the built-in thermal protector which automatically shuts off the current when a predetermined motor temperature is reached.

Control surfaces of all types, as well as landing gears, bomb bay doors, and other parts of a plane, may be so constructed as to be controllable by means of parallel wire connections running through the aircraft by different routes. This is provided to assure continued functioning of the intermittent-duty auxiliary electric motors, which operate control parts even if the plane is hit in combat.

Under the manufacturer's production system, auxiliary aircraft motors are built on four basic frame sizes. With these four fundamental designs, a standard-production line of eleven models has been achieved to serve virtually all purposes. The smallest of these has a 12-watt output, measuring $^1/_{62}$ hp. at maximum efficiency. Its weight is 0.81 lb. This motor, applied in a linear actuator with reduction gears and a standard linear screw, has a maximum operating load of 500 lbs., but its yield point is not reached until tension has increased to 1,500 lbs. Other actuators are being produced by Lear which have load capacities as high as 35 tons.

In the Rota-brake for applications where positive, accurate positioning is required electrically yet instant change-over to manual operation is necessary, the principle of the Fastop clutch is combined with a centrifugal brake.

The center portion of the drive disc is hollowed out to form an annular groove into which ball bearings are placed. When the drive and the driven discs are tight together and revolving at high speed, centrifugal force acts to throw the ball bearings up the walls of the groove. But the magnetic flux is too strong for the discs to be separated. At the moment the motor circuit is opened, however, the flux ceases and centrifugal force is unopposed. The bearings fly up the walls of the annular groove, force the separation between the two discs, and push the driven disc back against the cork face. Thus the braking action against the cork face is positive and instant. Lear Avia, Inc., Piqua, O.

Miniature Bomb Rack for Practice Bomb

Installed in the tunnel hatch of a PBM-3 Mariner patrol bomber is a new miniature bomb rack for practice bombs, developed by technicians at the Naval Air Station, Banana River, Fla.

So simple in construction that it can easily be manufactured by operating squadrons and training units from materials on hand, the miniature bomb rack is operated in an identical manner to the main bombing system of the PBM. The conventional firing key or "pickle" may be used by either the bombardier or pilot, and, while the miniature rack is mounted over the tunnel hatch, the bomb bay doors open in the conventional manner before the miniature bombs are released.

Used to train student pilots and bombardiers for operational duties, the miniature rack is mounted horizontally at the tunnel hatch by means of two fixed flanges on the after end of the rack, while the forward end is secured to the tunnel hatch slots by means of a spring-loaded hinge and held in place by dogs. Minor modifications of the Mariner's electrical system, requiring approximately 1 man-hour, complete the installation.

The miniature rack holds four Mark 23 miniature practice bombs and is cocked manually by a special cocking tool. The bombs can be released either in select or train as determined by the setting of the intervalometer. The Glenn L. Martin Company.

Aileron of New Design

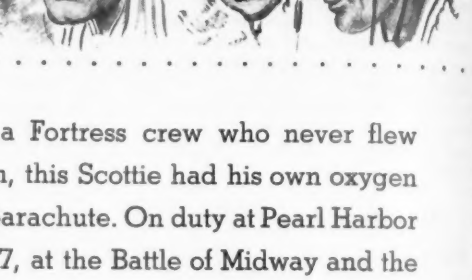
Better lift characteristics in airplanes for postwar air-line operators are expected to result from a new type aileron developed by William D. van Zelm. Supplying the same degree of rolling moment as the conventional Frise aileron with a 35–45 per cent reduction in span, the van Zelm design is reported to permit a considerable lengthening of the wing flaps, thus increasing capacity load or shortening take-off run and lowering landing speed. It also reduces drag caused by the gap between the conventional aileron and the trailing edge, tends to prevent ice formation in this gap, and is simple to fabricate.

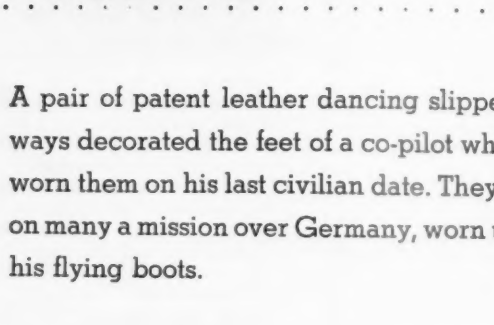
The van Zelm aileron was designed as a result of extensive research into the reasons for the lack of effective force on the part of conventional ailerons. These studies revealed that the projection caused by the balance portion of the leading edge of the aileron created a turbulence in the air beneath the aileron, resulting in a loss of effective roll and an increase in control force for angles of more than 15°.

They wouldn't fly without them . . .

Mascot of a Fortress crew who never flew without him, this Scottie had his own oxygen mask and parachute. On duty at Pearl Harbor December 7, at the Battle of Midway and the Guadalcanal campaign, he logged over 800 flying hours.

A pair of patent leather dancing slippers always decorated the feet of a co-pilot who had worn them on his last civilian date. They went on many a mission over Germany, worn under his flying boots.





A careful navigator used one of his best girl's nylon stockings to wrap around the lenses of his precious octant.

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To overcome this obstacle the new aileron incorporates an auxiliary airfoil in combination with a seal closing the gap between trailing edge and aileron, which smooths the air under the aileron when in an up position and at the same time balances the aileron with a force in the direction of roll, permitting twice as much upward deflection as with the conventional type. The auxiliary airfoil or slat is extruded from aluminum alloy and is attached to the leading edge of the aileron with metal clips or plates. In the neutral and down positions it fits into a cutout section of the trailing edge of the wing. Being a simple aluminum-alloy extrusion, the auxiliary airfoil is easily fabricated, yet it does not add weight since it replaces the metal weights used in former ailerons to bring the center of gravity forward of the hinge point to prevent flutter.

The improved aileron assembly employs a top hinge for attaching the aileron to the trailing edge. This removes all restrictions on upward deflection while still permitting a downward deflection of as much as 15°, the same amount provided by the conventional center-hinged aileron. The top hinge also simplifies the problem of sealing the gap between aileron and trailing edge, an essential feature of the design necessary to provide smooth airflow.

The seal itself is a spring-metal strip attached to the top of the aileron and running under a bulb section at the wing trailing edge. Since contact with the trailing edge is very close to the hinge line, friction is held to a minimum.

While the principal function of the seal is to provide smooth airflow in conjunction with the auxiliary airfoil, it offers the added advantages of eliminating drag and tending to prevent the formation of ice in the gap which might lock the controls. Wind-tunnel tests have shown that no drag results from irregularities at the bottom of the gap when the top is sealed.

Further advantages claimed for the new design include greater rigidity, since the hinge line is at the wing surface outside the aileron contour and the torque-box nose is not cut; better balance through the elimination of the torque-box carry-over structure, reducing weight aft of the hinge; and lower fabrication costs as a result of the simplification of the internal structure.

The van Zelm aileron has been test-flown successfully on an experimental B-26 Marauder, and is being incorporated in designs for postwar commercial aircraft where its added lift will mean greater pay load and reduced operating costs. The Glenn L. Martin Company.

Improved Method for Preparing Aircraft Cables

A mechanical "mouse" designed by employees and supervisors saves time and labor in the cutting of aircraft cables to length and crimping and swaging on terminals. The "mouse" consists of a pair of tension spring jaws and is attached to a chain that runs along the top of the 51-ft. cutting table and returns beneath the table. The chain is driven by a $^1/_2$-hp., 440-volt, three-phase motor and has a safety cover over its entire length to protect the operator's hands.

After swaging, the cable is placed in the "mouse" with the terminal butting against the jaws. The chain is started, and the "mouse" travels forward carrying the cable until it passes a stop that is preset at the desired cable length. As it passes the stop, a limit switch is tripped, causing the chain to reverse until the "mouse" is halted by the stop. This lights a red light in front of the operator telling him that the cable is in the proper position to be cut.

The operation of the shear as the operator cuts the cable trips another microswitch at the base of the shear, starting the chain forward again as soon as the cable is cut. The cable is then carried the length of the table and back beneath it. When the "mouse" is about three-fourths of the distance back, a piece of angle iron spreads the jaws and the cable drops into a wooden trough. The "mouse" continues on until it trips another limit switch which stops it in front of the operator ready for the next cable.

The entire cycle is automatically controlled and the operator never moves from the end of the table. The only manual operations are attaching the cable, starting the chain, and lowering the shear. While the cable is being carried along the table and dropped into the trough after cutting, the operator is left free to crimp and swage the terminal on the next cable.

The stop is of unusual design, permitting the "mouse" to pass only when traveling in a forward direction, on the same principle as a turnstile, and stopping the "mouse" only when it is carrying a cable. The trip arm is made of fiber with the exception of a small metal insert to make contact with the "mouse," and is held in place by a compression spring. The jaws of the "mouse" are likewise made of fiber except for the cutout for the cable and are insulated against each other when empty. When the cable is inserted, however, it completes the circuit, causing the limit switch to stop the "mouse." The Glenn L. Martin Company.

Portable Unit for Testing Airplane's Electrical Systems

A Circuit Analyzer designed and built by four inspectors is credited with having brought about savings of 12,300 man-hours in the inspection of bombers. The Circuit Analyzer is a compact portable unit containing equipment for testing every wire and piece of electrical equipment in the airplane. It is flexible enough to permit necessary modification for meeting engineering changes and is operated by plugging into the various circuits of the airplane.

The analyzer is designed to test the wiring of the airplane, section by section, at a low voltage for continuity before the fuselage is spliced. It tests and operates all operational units and lighting systems at their required voltage. Every main wire that runs to a switch or some piece of electrical equipment is tested by the use of cable runs connected to the test set, and other ends having Cannon plugs or terminals to connect to the plugs or terminals in the section. Wires that cannot be tested in this manner are tested on a separate circuit using a point-to-point continuity test using lights and buzzers in the circuit. The bomb system and the auxiliary boxes on all bomb racks are tested and operated from the bomber's circuit plug by an adapter circuit that works into the bomber's circuit in the test set. The Glenn L. Martin Company.

Fast-Working Clamp

The Cam-O-Lok clamp is made in three types, for light, medium, and heavy duty. It is adjustable over the entire range of its vertical holding capacity. When objects to be held vary in thickness, no adjustment of the hold-down bolt is necessary to obtain the desired clamping pressure. Locking and unlocking are accomplished by means of a threaded element in the positioning handle. Lubrication is provided for the threads. Mechanics Engineering Company, Jackson, Mich.

Metallizing Gun

The Metco Type 3E metallizing gun is designed for the high-speed production spraying of low-melting-point metals. Coatings of $^1/_8$-in. zinc, tin, lead, solder, babbitt, cadmium, or fine-gauge copper and copper alloys can be sprayed at high rates of deposition. The manufacturer states that the following are typical rates, in pounds per hour: zinc, 40; tin, 70; lead, 110; solder, 90; babbitt, 75.

Regardless of the type of wire employed, no gear changes are necessary to achieve high speeds. Any spraying speed within the prescribed ranges is obtained and maintained over long periods by the patented controlled-power unit that is an integral part of the gun. Air-pressure fluctuations do not affect its operating efficiency. The Type 3E is equipped with a universal gas head, which allows the tool to be operated on any commercial gas in conjunction with oxygen and compressed air. A duplex mounting fixture is provided for permanent installation.

Users of Metco Type E or 2E guns may have their present equipment quickly converted to a Type 3E. Or, should the demand arise at a later date, the Type 3E may then be converted back to the standard Type E or 2E. Metallizing Engineering Company, Inc., Long Island City, N.Y.

Microfilm Process

The Microcopy Translite Hi-Reduction process is the application of microfilming to engineering drawings, as well as to any other valuable record, document, drawing, map, or material kept in manufacturing-plant files. It is par-

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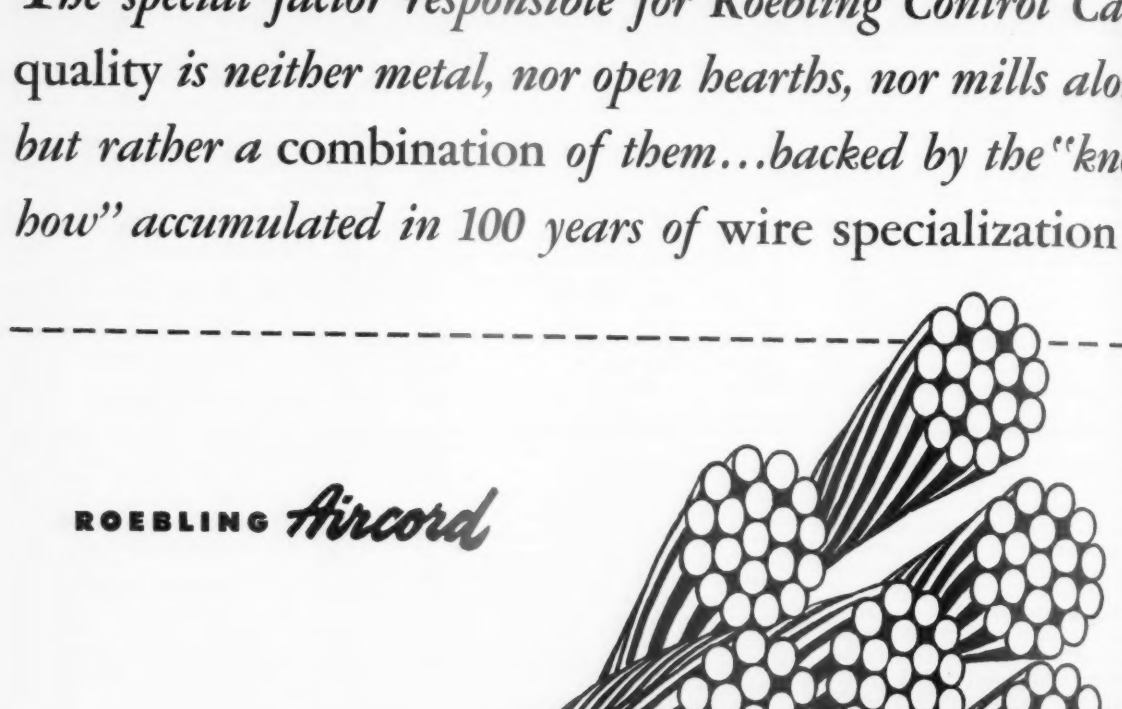

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Since Microcopy reduction photographs of records are on a continuous roll, the master files are safeguarded against tampering, extraction, and substitution. Filing space is reduced by 90 to 98 per cent.

For reading these microfilmed records a multiple-magnification viewer is supplied in various models. The viewer is operated from a control panel, on a motion-picture film projector principle. It facilitates finding locations on films by permitting enlargements to be made on the screen, as well as permitting any portion of the frame to be centralized within the frame for easier reading. Microcopy Corporation, Burbank, Calif.

Cargo Unit's Responsibilities

For efficiency and expediency in loading of international air cargo aboard the transatlantic Clippers of Pan American World Airways, the Cargo Unit at the North Beach (New York) airport has been assigned the responsibility of loading and unloading all cargo for all aircraft operated by the company's Atlantic Division at North Beach. This includes both regular Clippers operating over-ocean services and naval aircraft operated by Pan American crews under contract.

Previously, four departments participated in the movement of air cargo at the airport—the Airport Office of the Operations Department, airport porters of the Purchasing Department, the beaching crews of the Maintenance Department, and the Cargo Unit of the Traffic Department. The new duties will be in addition to those previously handled by the Cargo Unit—that is, weighing, checking, classifying, listing, measuring, labeling, etc.—to insure maximum cargo load aboard each flight, proper stowing for en-route delivery, and correct balance. Pan American World Airways System.

Users' Guide for Self-Tapping Screws

Engineering and production data about the application of self-tapping screws are given in a new users' guide offered to design engineers, chief draftsmen, and production executives.

The 18 pages are of file size, tab-indexed, spiral bound, and arranged with a strong wall hanger. The guide includes a selector chart that tells at a glance which of nine types of self-tapping screws to use in various materials. Tables give recommended hole sizes, stock sizes, and data concerning the use of each type of self-tapping screw under different conditions.

Application information includes the use of self-tapping screws in sheet metal, steel, castings, plastics, plywood, asbestos, and other compositions. Special heads and special forms of self-tapping screws that can be made for specific needs also are shown. Parker-Kalon Corporation, New York.

Table-Type Continuous Print Dryers

For overall drying of blue prints or black-and-white prints, a compact electrically heated dryer is available in two sizes, one for handling 26-in. and one for 44-in. width prints.

In addition to standard heat regulation as provided, the B-8 dryers are equipped with variable-speed drive motors and controllers. This permits instantaneous speed changes over a range of 6 in. to $3^1/_2$ ft. per min. Current consumption for the 26-in. dryer is 14 amp. at 110 volts or 7 amp. at 220 volts. For the 44-in. dryer it is 23 amp. at 110 volts and 12 amp. at 220 volts.

Features of construction noted by the makers are the pressed-steel framework; woven seamless band; seamless copper revolving drum; steel clad, refractory-insulated Nichrome heaters; nickel contacts; and asbestos-insulated nickel wire. Peck and Harvey, Chicago.

Adhesive for Plywood Bonding

Amberlite PR-75-B is a low-temperature-curing adhesive of the phenol-formaldehyde type for bonding a wide variety of heavy lumber and timber constructions. It is useful in the manufacture of oak ship keels and laminated structural members for columns, timbers, arches, and trusses, and is proving especially adapted to aircraft work, such as wing and fuselage assembly gluing, hollow-spar construction, and scarf jointing.

It is supplied as a viscous reddish-brown solution, which is infinitely dilutable with alcohol and can also be diluted with water to any practical spreading consistency needed. It has a storage life of a year at room temperature. It is used with Catalyst P-79, which is added at the time of use to effect proper cure. The cured glue line exhibits a pH in the range 6–7 and meets the strength and durability requirements of Army-Navy Specification AN-NN-P-511b (Plywood, Aircraft, Flat Panel) as well as the strength, durability, and acidity requirements of Bureau of Ships Specification 52-G-12 (Interim) (Glue, Phenol Formaldehyde, Low Temperature Setting) and the new Army Air Forces Specification 14124 (Glue, Low Temperature Setting).

Preparation of the glue is a relatively simple operation, requiring no special equipment or unusual techniques. The resin solution is first weighed into a suitable container, the catalyst is then added, and the mixture is stirred until the catalyst is uniformly dispersed. Water at normal room temperature is added to the mixture and, after brief stirring, the glue is ready for use.

After correct formulation, the glue contains approximately 70 per cent solids and exhibits a viscosity that is suitable for spreading by brush or mechanical spreaders. The working life of the glue should be considered as approximately 4 hours at 70°F. and the glue can be spread at any time throughout the period of its useful life. Liquid glue spreads of 50-60 lbs. per 1,000 sq.ft. of glue line are recommended. The construction is laid up as soon as possible after the glue is spread. Total assembly time before pressure is applied should be at least 10 min. and not more than 4 hours.

Moisture content of the wood is not a critical factor in bonding with Amberlite PR-75-B. Results obtained with birch plywood and with oak and maple blocks indicate that moisture content in the range of 6 per cent to 14 per cent can be tolerated, although the optimum is approximately 10 per cent. Adjacent layers should not vary in moisture content by more than 2 or 3 per cent. Specific pressures used must be sufficient to bring the glued surface into intimate contact. Under ideal conditions pressures as low as 25 lbs. per sq.in. are adequate. Hydraulic, pneumatic, and gravity pressures are preferable although hand clamps can be used under optimum conditions. The time required under pressure will depend directly on the temperature attained at the innermost glue joint in a given construction. Bonding schedules are determined by measuring with thermocouples the temperatures attained at the innermost glue joint at the kiln temperatures indicated. As an example, a heavy laminated timber would require that temperature at the innermost glue line be held at 180°F. for 1 hour. Resinous Products & Chemical Company, Philadelphia.

Emergency Plug-Gauge Blank Sets

The Atlantic emergency set contains 36 cylindrical plug-gauge blanks, in steps of $^1/_{16}$ in., with handles. It is designed to permit any shop to produce plug gauges of any size from 0.029 to 1.000 in. with only a few minutes of work on a cylindrical grinding machine. The plug-gauge blanks are oil hardened throughout, the shank is finish ground, and centers on both ends are lapped. It is necessary only to grind the blanks to produce a finished commercial gauge. Where higher standards and closer tolerances are involved, the gauges are then lapped. George Scherr Company, Inc., New York.

"Push-Pull" Circuit Breaker for Aircraft

The Klixon D-6751 is a new aircraft circuit breaker with a "push-pull" feature. The pull feature permits the opening of the circuit breaker manually, in order that maintenance and repairs to the circuit can be accomplished without de-energizing the entire system.

The pull to the "off" position requires deliberate action and retains the desirable feature of being safe against accidental tripping when operating adjacent switches. The push-pull button travels outwardly approximately $^1/_4$ in. upon tripping and exposes a three-colored band, part of which is luminous so that indication is given under all conditions. A specially designed shunting

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3. *Have wire wound stability and are physically interchangeable with carbon types.*
4. *Available in matched pairs to 1% or 2% for close-tolerance, high-stability applications.*
5. *Element is space wound with copper-nickel or nichrome bare wire securely crimped and molded integrally with leads.*

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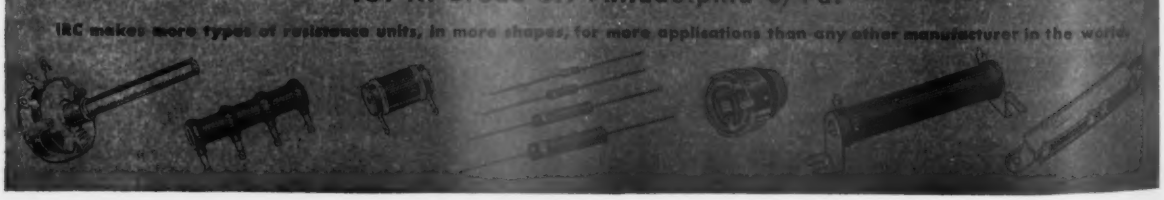


switch is incorporated, which provides "non-trip-free" action.

Compact and light in weight, the Klixon push-pull breaker will carry at least 120 per cent of rated current continuously and trip ultimately at 138 per cent of rated current in an ambient temperature of 25°C. (77°F.). The D-6751 meets usual requirements of shock, vibration, and motion regardless of the position of mounting. It is available in ratings from 5 amp. through 50 amp. with standard AN mounting dimensions, and is suitable for 30-volt d.c. systems. This equipment conforms to Navy specifications M-538 and NAF-1213. Spencer Thermostat Company, Attleboro, Mass.

Celestial-Navigation Calculator

The Starmaster is a spiral slide rule 10¾ in. in diameter, designed for the solution of spherical triangles encountered in celestial-navigation problems. It is equivalent to a straight slide rule 170-in. long.

There are two distinct scales; one in the colored bands for multiplying or dividing functions of angles; and one in the white bands for combining certain results from operations on the colored bands. Colored bands, which are interlaced with the white bands, are alternately green and yellow, and the numerals are in bold type. This arrangement is intended to provide for easy location of the proper angles.

The device is mounted on a rigid Masonite base and is heavily coated with Vinylite to guard against distortion from heat, cold, or moisture, and to assure permanent accuracy. The two indicators are made of Vinylite 0.4 in. thick and sufficiently wide to guard against deflection.

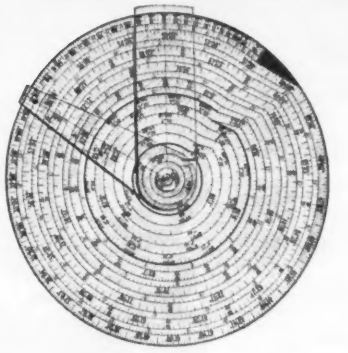
The makers state that, with practice in the use of the instrument, determination of altitude can be made in 1½ min., and that of the azimuth in an additional ½ min. Other solutions are relatively rapid. Results are well within the range of accuracy of the observations on which celestial navigation is based.

The instrument is intended to take the place of such methods of celestial navigation as HO-211, HO-214, and HO-218. It is claimed to be faster than HO-211, and as fast as HO-214 and HO-218. Spiral Slide Rule Company, Chicago.

Double-Acting Auxiliary Engine

Utilization of the double-acting principle, whereby power is applied to both sides of a piston instead of one as in the conventional four-cylinder engine, enables the new Tabor-Hedges auxiliary engine to deliver 32 hp. at 2,200 r.p.m. at 5.1 lbs. per hp.

In the new engine, cooling is accomplished by drawing off approximately one-third of the excess heat from the inside of the cylinder in addition to the normal cooling by conventional fins on the outside. This is done by drawing carburetor-intake air through ports located in the middle of the cylinder. The air circulates around the specially



The Starmaster celestial-navigation calculator.

designed hollow piston, which is cut away on opposite sides of the walls to permit a free flow of air. In addition, fins are built into the inner sides of the pistons and baffle plates direct the air to them.

The engine's crosshead consists of a wrist pin mounted at each end in ball bearings; the pin is securely attached to the piston rod, since the outer connecting-rod bearing is forked to make this possible. Ball bearings run between two hardened steel guides of 0.003–0.005-in. clearance. These guides are self-aligning, which simplifies assembly procedure and maintains even pressures in operation.

Since, in a double-acting engine, the crosshead takes all angular thrust, the piston "floats" in the cylinder, main contact between the two being through the rings. Design of the seal between piston and crankcase is such that no bending strain is imparted to the piston rod; thus, it is under only normal compression and tension, there being no force other than inertia of the rod, wrist pin, and connecting rod resisting the shift from one set of guides to the other.

Only two crosshead shifts take place in each cylinder during the cycle. One takes place at the end of the second power stroke, when the crosshead is practically stationary and the connecting rod changes from driving the crankshaft to being driven. The other shift occurs between compression and the first power stroke, at the moment when the horizontal component of the power stroke, set up by the angularity of the connecting rod, is sufficient to overcome the inertia of the moving parts involved. Since this is a negligible force at the top of the stroke, it is stated that hammer has been eliminated.

The Tabor-Hedges engine has been designed for continuous operation at 2,200 r.p.m., as compared with units that run at speeds up to more than 4,000 r.p.m. Test runs have shown that the engine will deliver 30 hp. at 2,200 r.p.m. for continuous operation, under which conditions it is rated at 5.45 lbs. per hp.

Designed to use 68–72-octane gasoline, the engine consumes 0.54 lb. per hp.-hr. at maximum rated horsepower. However, test runs have been made with 90–100-octane fuel without increasing the 6-to-1 compression ratio, and it was found that the engine ran cooler than with the lower-rated fuel.

Specifications and performance data of the engine are given by the manufacturer as follows: two cylinder; four-stroke cycle; bore and stroke, 3⅝ by 3⅝ in.; compression ratio, 6 to 1 (for 68–72 octane fuel); maximum hp., 32 at 2,200 r.p.m.; continuous-operation horsepower, 30 at 2,200 r.p.m.; weight without equipment, 163.5 lbs.; ignition, magneto; height, 26 in.; width, 21 in.; length, 26 in. The Tabor Manufacturing Company, Philadelphia.

Plywood "Rocket" Targets

The War Department has permitted the manufacturer to reveal that the tail assemblies or "fins" of target rockets are made of plywood. Orders totaling 2,400,000 of these fins have been delivered, which, on a square-foot basis, represent approximately 5,120,000 ft. of ¼-in. three-ply waterproof fir.

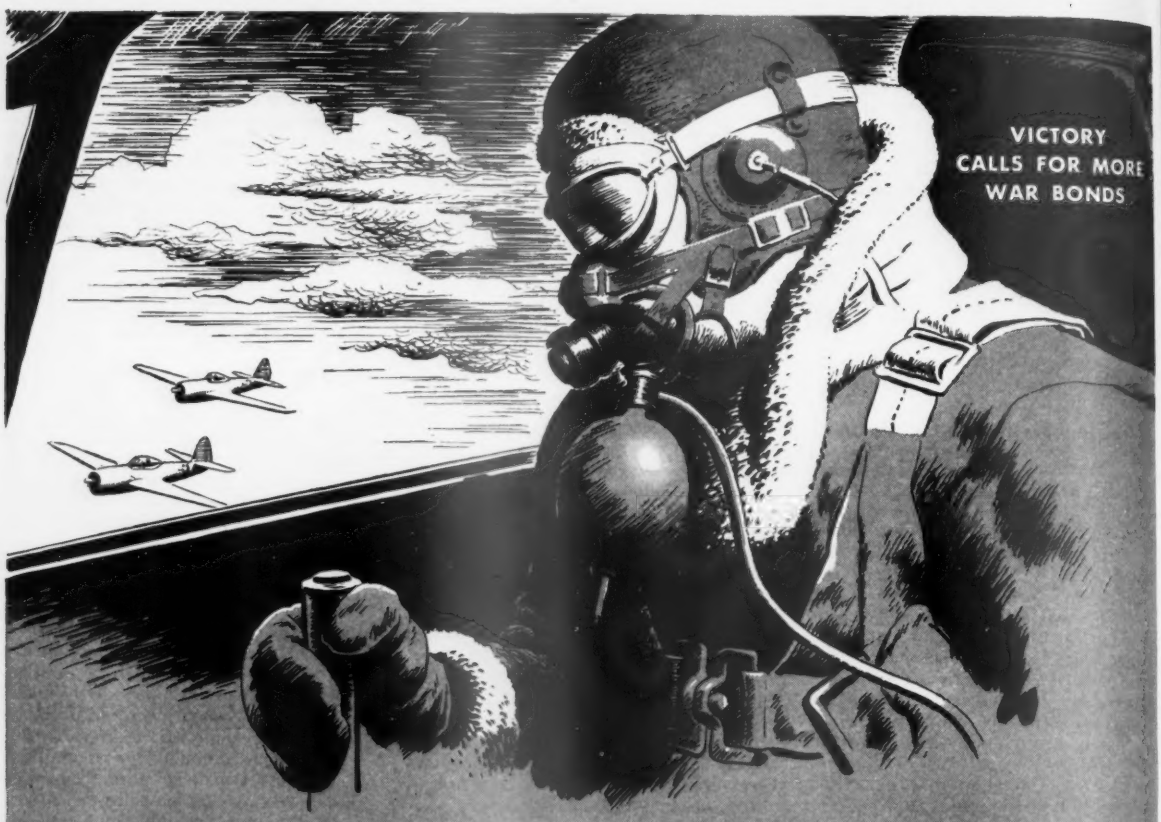
This rocket target replaces to a large extent the familiar sleeve target towed by an airplane at a relatively slow speed. Its use is reported to improve the accuracy of antiaircraft gunners. The rocket's speed duplicates the speed of the fastest enemy aircraft, and its use saves gasoline and releases target-towing planes and pilots for other duties.

Although the rocket target has been in quantity production since December, 1941, its details are only now being disclosed by the military services. The rockets are launched from a wheeled projector by means of an electrical connection leading from the center of the firing trough. They can be fired from unknown and varied angles, so that the speeding rockets give antiaircraft gunners a realistic opportunity to develop alertness and accuracy in firing. United States Plywood Corporation.

Rubber Used in the B-29

It is reported that nearly 2 tons of synthetic rubber are required to make the 30 bullet-sealing fuel tanks of the Boeing B-29. Although the total weight of rubber in this plane is close to 5,000 lbs., the tires and tubes have been redesigned and are stated to be the lightest per pound of load in any airplane. The six tires and tubes in the tricycle landing gear formation weigh only 1,288 lbs. and contain less than 600 lbs. of rubber.

More than 200 rubber items enter into the construction of each of the B-29 bombers. In addition to fuel cells, tires, tubes, and bullet-sealing hose, these rubber items include flexible connections for the superchargers, upholstery, cellular rubber supports for fuel cells, washers, gaskets, grommets, and shock pads of sponge rubber. Other nonrubber items furnished by United States Rubber Company include asbestos air ducts to conduct hot gases, waterproof engine-cover materials, and an anti-adhesion material to prevent doors from jamming. United States Rubber Company.



7 MILES UP

but the tests start on the ground

There are some pretty tough research problems that have to be licked before a plane can put 40,000 feet between itself and the earth. One of them is the problem of maintaining efficient temperatures of jacket coolant, lubricating oil and fuel mixture at all altitudes from sea level to stratosphere —from 100 degrees above zero to 67 degrees below. And since it is hardly practical to take a laboratory into the stratosphere, Herrison has brought the stratoshpere down to the laboratory by means of an Aviation Test Room, where weather conditions are "made to order."

In the Aviation Test Room, sub-zero temperatures can be accurately controlled to simulate those of flight at various speeds and altitudes. Harrison aircraft products are tested and tested again . . . put through their paces under the most exacting conditions of stratosphere flight by Harrison engineers. And from the performance records obtained have come many improvements and refinements to help "raise the ceiling" of America's high-altitude planes.

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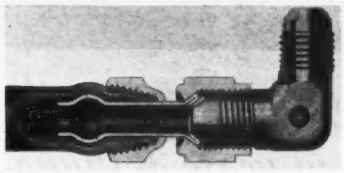
Low-Pressure Hose Fitting

The low-pressure Q-A fitting for instrument and low-pressure hydraulic hose lines is designed to meet the requirement whereby higher pressure effects a tighter seal between hose and fittings.

A floating seal is obtained by the design, which involves a simple assembly of stem and coupling nut, and a free sleeve nut. Hose is run onto the stem which is provided with an annular hump. By reason of its wide-angle gripping threads, the sleeve nut, as it is turned onto the hose, becomes an integral part of it. As the pressure is applied, it forces the stem out and pulls the hose and tapered sleeve nut against the stem hump. As pressure increases, the seal is tightened. When pressure is decreased, the seal relaxes.

Because the sleeve nut engages hose



Weatherhead's new low-pressure Q-A fitting.

rather than another metal part, a single wrench is the only tool required for assembly, and the necessary torque is usually less than 25 in.lbs. Assemblies on hose with internal diameters from $1/4$ to $3/4$ in. have been made without tools. Finger-tightened connections have held against pressures that finally burst the hose to which they were connected. The fitting is re-usable, either on its original hose or on new lengths. The Weatherhead Company, Cleveland.

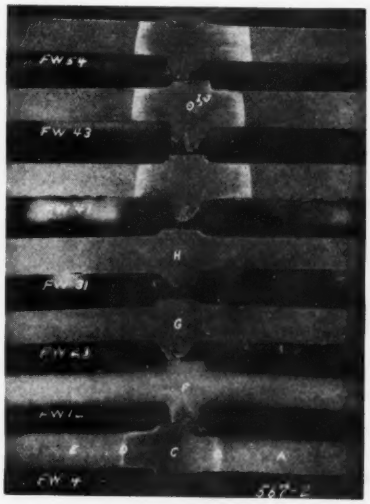
B-29's Horsepower

With a total of 8,800 hp. from the four air-cooled, radial Wright Cyclone 18 engines, the Superfortress has almost doubled the power of the Boeing B-17 Flying Fortress, which has 4,800 hp. Indicative of the weight in bombs, guns, and gasoline which the new Boeing bomber can carry is the fact that it has from 2,400 to 3,800 more power than the biggest bomber, such as the Lancaster or Halifax, used by the British in their night raids. It tops the largest four-engined bomber of the Germans, the Focke-Wulf Kurier, by 2,800 hp. The Boeing B-29 bomber has more than double the power of the biggest bomber of the Japanese, which, according to the latest published reports, is the Kawasaki T97, with four engines of only 900 hp. each. Wright Aeronautical Corporation.

(*Continued from page 121*)

Flash welds in normalized tubing are satisfactory from the standpoint of static and impact strength. (2) Flash welds in normalized tubing are satisfactory from the standpoint of static and impact strength, when given subsequent heat-treatments up to 160,000 lbs. per sq.in., the highest heat-treatment investigated. (3) Flash welds in heat-treated tubing without subsequent heat-treatment, however, may develop weld failures under both static and impact test, apparently with considerably lowered energy-absorption values. (4) Regardless of the welding method, the subject of fractures occurring at the weld should be investigated since failures of this type tend to give a reduction in energy absorption under impact or shock. (5) Notches and abrupt changes in section are decidedly detrimental to impact strength and should be avoided. (6) An important factor in the impact strength of fish-mouth arc welds is the degree of penetration at the apex of the fish mouth. Measures should be taken to assure adequate penetration and freedom from cracks in this region. (7) The total energy absorption is greater under conditions of dynamic loading than under static loading. (8) Energy absorption, as well as the shape of the load-strain curve, is a function of the geometry of the specimen. Hence, caution should be exercised in translating the results of tests on small, highly idealized specimens to actual structural parts. Appendixes to the first part of the article discuss impact-test apparatus, the derivation of energy formulas, and general considerations.

The second part of the report deals with fatigue tests on tubing of the same dimensions. It follows the same general outline as Part I. The following conclusions are made: (1) Flash welds in normalized tubing, tested as-welded, appear to be generally superior to arc welds from the standpoint of fatigue characteristics. (2) From the stand-



A macrograph of typical unfailed welds after tests, showing weld junction. (From *The Dynamic Properties of Flash-Welded Tubing.*)

point of fatigue strength, flash welding followed by heat-treatment is preferable to heat-treatment followed by flash welding. (3) Small nicks in normalized tubing are detrimental to fatigue strength. (4) Fish-mouth arc welds under fatigue loading fail through the apexes of the welds. When high fatigue strength is required, therefore, particular attention must be paid to obtaining good penetration and freedom from cracks and porosity in this region. *The Welding Journal*, June, 1944, pages 280-s–302-s, 53 illus.

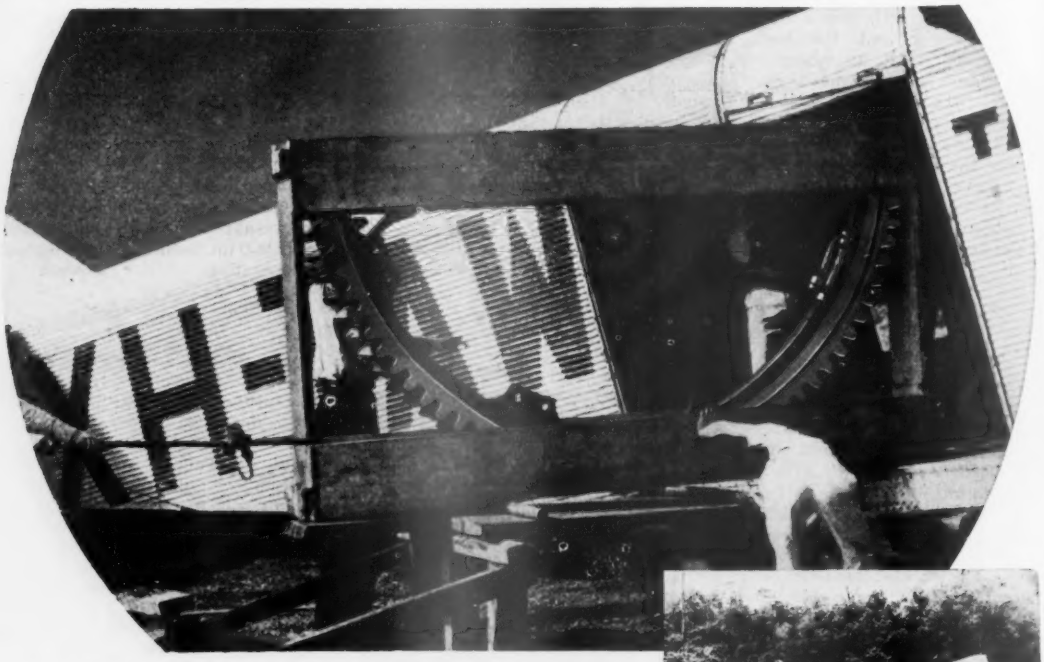
Welding Fixtures. Part I: Practical Considerations in Designing Work-holding Equipment; Some Simple Assemblies. Harold B. Periera. This is the beginning of a continued article offering suggestions on how to design work-holding equipment for welding operations. Part I summarizes general considerations in designing welding fixtures and discusses the construction of some simple assemblies. Among the equipment described are a welding fixture for holding two assemblies—one for a small tube assembly and one for a pipe clip—and a box-type of fixture for welding a seat bracket. *Aircraft Production*, June, 1944, pages 277–279, 8 illus.

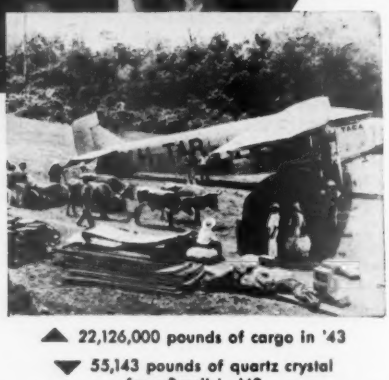
Fabrication and Welding of Exhaust Manifolds. C. D. LaFond and J. R. Plautz. A paper dealing with the manufacturing and welding phase of the modern aircraft exhaust system. As a prelude to the main discussion, the writer reviews some of the design problems. The methods of manufacture employed by the Buhl Stamping Company are described. Stainless-steel drawing operations and welding techniques are discussed in considerable detail. The greater part of the welding is done by the oxyacetylene process. Because of lack of available information, it was found necessary to carry out some metallurgical investigations, and these are described. *The Welding Journal*, June, 1944, pages 501–504, 7 illus.

Miscellaneous

Commercial Aviation's Fifth Annual Aircraft and Engine Review. This is a compendium of the aircraft and aircraft engines of various countries. The section on aircraft includes photographs, descriptive data, and specifications of American, Canadian, British, Russian, German, Japanese, and Italian airplanes. It also shows American and British gliders and helicopters. The section on engines covers only British and American types. Although photographs are shown for the majority of the models, they are omitted in some cases. *Commercial Aviation*, June, 1944, page 70 and following pages, 216 illus.

"BG spark plugs have proven their reliability in TACA'S planes during ten years of flying in Latin America."





▲ 22,126,000 pounds of cargo in '43

▼ 55,143 pounds of quartz crystal from Brasil in '43

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Institute News

Aeronautical Engineering Catalog

The 1944 edition of the AERONAUTICAL ENGINEERING CATALOG, announced in previous issues of the REVIEW, has now been printed and will be bound and distributed next month.

Because of the shortage of paper, the CATALOG print has been limited. Copies will be supplied without charge, upon written request, to Institute members in good standing who can use them to advantage.

The Catalog contains 502 pages, subdivided into eight sections. The first section gives an alphabetical listing of all companies, divisions, and subsidiaries of the 125 companies whose catalogs are contained in the Catalog Section. The Catalog Section contains 300 pages of individual company catalogs arranged in initial alphabetical order for ready reference.

A sixteen-page section gives information about the activities, services, and publications of the Institute. In a separate section is a selected list of 1,400 aeronautical technical books published from 1930 to 1944.

An alphabetical list of over 2,100 materials, parts, and accessories used in the construction of aircraft, together with the names of manufacturers of each individual product, comprises the Products Directory Section of the CATALOG. The products of over 1,500 manufacturers are listed in this section. A cross index of all the headings used in the Products Directory Section facilitates its use as a convenient reference source. Tear-out post cards are also included for use in requesting further information about cataloged products.

A list of the names and addresses of the principal manufacturers of air-borne aircraft products is also included. A trade name index comprises the last section.

The listings in this first edition of the CATALOG have been limited to air-borne products—that is, products and materials that enter into the design and construction of the airplane and its power plants.

Members of the Institute Visit Wright and Patterson Fields

By special invitation a group of 66 members of the Institute visited Wright Field and Patterson Field on June 16 and 17, for an organized tour and inspection of the facilities and operations of the Matériel Command and the Air Service Command.

After the first day's tour of Wright Field a dinner for the members and officers was held in the Engineer's Club of Dayton on the evening of June 16. A speaking program followed the dinner. L. Welch Pogue, Chairman of the Civil Aeronautics Board, spoke on "America's Stake in the Aeronautical Sciences." Major Gen. W. H. Frank, of the Air Service Command, Patterson Field, and Brig. Gen. F. O. Carroll, of the Matériel Command, Wright Field, spoke informally. Edward P. Warner, Vice-Chairman of the Civil Aeronautics Board, gave a brief talk on "Notes on Aircraft Development." Grover Loening, Consultant, War Production Board, told of "The Birth of the Aircraft Industry in Dayton." Col. J. G. Vincent, Vice-President of Engineering of the Packard Motor Car Company, spoke on "Early Days of the Engineering Division." The program was held in the auditorium of the Engineer's Club, and members from Dayton and the vicinity were also invited to attend. About 150 members and their guests were present.

A complete list of those who made the visit follows: Preston R. Bassett, Vice-President in Charge of Engineering, Sperry Gyroscope Company, Inc.; Rex B. Beisel, Engineering and General Manager, Chance Vought Aircraft Division, United Aircraft Corporation; George W. Brady, Chief Engineer, Propeller Division, Curtiss-Wright Corporation; Rowland Burnstan, President and General Manager, Lawrance Aeronautical Corporation; Frank W. Caldwell, Director of Research, United Aircraft Corporation; V. E. Carbonara, Chief Engineer, Kollsman Instrument Division, Square D Company; Carl de Ganahl, Director of Research, Fleetwings Division, Kaiser Cargo, Inc.; R. H. Depew, Jr., Manager, Special Projects, Fairchild Aircraft Division, Fairchild Engine & Airplane Corporation; R. N. Du Bois, Executive Engineer, Packard Motor Car Company; William K. Ebel, Vice-President in Charge of Engineering, The Glenn L. Martin Company; Graham Edgar, Vice-President and Director of Research, Ethyl Corporation; William R. Enyart, President and General Manager, Simmonds Aerocessories, Inc.; Sherman M. Fairchild, Chairman of the Board, Fairchild Engine & Airplane Corporation; Frederic Flader, President, Frederic Flader Company; R. H. Fleet, Consolidated Vultee Aircraft Corporation; J. C. Franklin, Vice-President of Engineering, T.W.A., Inc.; Charles Froesch, Chief Engineer, Eastern Air Lines; R. C. Gazley, Executive Engineer, The Cleveland Pneumatic Tool Company; R. T. Goodwin, Manager, Aviation Department, Shell Oil Company; A. T. Gregory, Chief Engineer, Ranger Aircraft Engines Division, Fairchild Engine & Airplane Corporation; R. P. Harrington, Head of the Department of Aeronautical Engineering, Polytechnic Institute of Brooklyn; J. A. Herlihy, Vice-President in Charge of Operations, United Air Lines Transport Corporation; R. Insley, Vice-President and Executive Engineer, Continental Motors Corporation; Eastman N. Jacobs, Special Technical Consultant, N.A.C.A.; C. N. Jamieson, Chief Engineer, Culver Aircraft Corporation; Roger W. Kahn, Test Pilot and Manager of Service Department, Grumman Aircraft Engineering Corporation; I. M. Laddon, Vice-President, Consolidated Vultee Aircraft Corporation; Harley W. Lake, Manager, Aviation Department, Socony Vacuum Oil Company, Inc.; Jerome Lederer, Chief Engineer, Aero Insurance Underwriters; John C. Leslie, Division Manager, Pan American Airways, Inc.; Paul W. Litchfield, President, Goodyear Aircraft Corporation; William Littlewood, Vice-President in Charge of Engineering, American Airlines, Inc.; Grover Loening, Consultant, War Production Board; Alfred Marchev, President, Republic Aviation Corporation; Earle Martin, Engineering Manager, Hamilton Standard Propellers Division, United Aircraft Corporation; C. J. McCarthy, Vice-President, United Aircraft Corporation; R. J. Minshall, President, Pesco Products Company,

A photograph of members of the Institute and officers from Wright and Patterson Fields, taken before the tour of Wright Field on June 16. (1) Major L. D. Mitchell, (2) R. C. Oertel, (3) V. E. Carbonara, (4) Graham Edgar, (5) Paul W. Litchfield, (6) Lester D. Gardner, (7) Orville Wright, (8) Major Gen. B. E. Meyers, (9) R. H. Fleet, (10) Brig. Gen. F. O. Carroll, (11) R. J. Woods, (12) Charles Froesch, (13) R. H. Prewitt, (14) Col. J. G. Vincent, (15) Eastman N. Jacobs, (16) Edward P. Warner, (17) Rowland Burnstan, (18) Roger Wolfe Kahn, (19) David C. Prince, (20) Alfred Marchev, (21) Rex B. Beisel, (22) Earle Martin, (23) A. T. Gregory, (24) C. J. McCarthy, (25) R. H. Wendt, (26) William Littlewood, (27) L. Welch Pogue, (28) J. C. Franklin, (29) Sherman M. Fairchild, (30) J. Carlton Ward, Jr., (31) Fred E. Weick, (32) Bennett H. Horchler, (33) Earl D. Osborn, (34) Preston R. Bassett, (35) Grover Loening, (36) Lt. Col. G. R. Johnston, (37) R. H. Depew, Jr., (38) Carl de Ganahl, (39) Ralph H. Upson, (40) C. F. Nagel, (41) J. A. Herlihy, (42) G. M. Williams, (43) H. A. Sutton, (44) George A. Page, Jr., (45) R. W. Rummell, (46) R. J. Minshall, (47) Norton B. Moore, (48) William K. Ebel, (49) Robert R. Osborn, (50) R. P. Harrington, (51) R. C. Gazley, (52) Robert R. Dexter, (53) John C. Leslie, (54) I. M. Laddon, (55) Harley Lake, (56) Michael Watter, (57) George W. Brady, (58) James S. Pedler, (59) C. M. Jamieson, (60) Frank W. Caldwell, (61) George R. Forman, (62) Robert D. Spencer, (63) F. R. Shanley, (64) Capt. J. H. Lumpkin, (65) Lt. R. J. Failor, (66) Capt. R. L. Winters, (67) William R. Enyart, (68) Jerome Lederer, (69) J. M. Shoemaker, (70) Harry Woodhead, (71) Lt. R. G. Bartlett, (72) Frederic Flader, (73) R. T. Goodwin, (74) Lt. H. K. Hardy, (75) Lt. J. E. Arnoult, (76) Lt. Buckley, (77) Lt. N. Goodwin.

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Division of Borg-Warner Corporation; Norton B. Moore, Associate Director of Research, Buffalo Airplane Division, Curtiss-Wright Corporation; Arthur Nutt, Vice-President in Charge of Engineering, Wright Aeronautical Corporation; Robb C. Oertel, Manager, Aviation Sales Department, Standard Oil Company of New Jersey; Earl D. Osborn, President, Edo Aircraft Corporation; Robert R. Osborn, Helicopter Research Division, McDonnell Aircraft Corporation; George A. Page, Jr., Director of Engineering, Buffalo Airplane Division, Curtiss-Wright Corporation; James S. Pedler, Manager, Aeronautical Division, The B. F. Goodrich Corporation; L. Welch Pogue, Chairman, Civil Aeronautics Board; R. H. Prewitt, Vice-President in Charge of Engineering, Kellett Aircraft Corporation; David C. Prince, Vice-President of Engineering, General Electric Company; R. W. Rummell, Senior Engineer, T.W.A., Inc.; F. R. Shanley, Chief Structures Engineer, Lockheed Aircraft Corporation; J. M. Shoemaker, Chief Engineer, Chance Vought Aircraft Division, United Aircraft Corporation; Robert D. Spencer, Manager of Aero Department, The General Tire & Rubber Company; H. A. Sutton, Aero Engineer, Consolidated Vultee Aircraft Corporation; Ralph H. Upson, New York University; J. G. Vincent, Vice-President of Engineering, Packard Motor Car Company; J. Carlton Ward, Jr., President, Fairchild Engine & Airplane Corporation; Edward P. Warner, Vice-Chairman, Civil Aeronautics Board; Michael Watter, Chief Engineer, Aircraft Division, Edward G. Budd Manufacturing Company; Fred E. Weick, Chief Engineer, Engineering & Research Corporation; R. H. Wendt, Vice-President, Taylorcraft Aviation Corporation; G. M. Williams, President, Consolidated Vultee Aircraft Corporation; R. J. Woods, Chief Engineer, Bell Aircraft Corporation; Robert R. Dexter, Secretary, I.A.S.; George R. Forman, Assistant to the President, I.A.S.; Lester D. Gardner, Chairman of the Council, I.A.S.; Bennett H. Horchler, Executive Vice-President, I.A.S.

Orville Wright—Publisher

Mr. Wright has sent to the Aeronautical Archives of the Institute several copies of papers that he published before he and his brother became interested in aviation. Many distinctions have come to one of the greatest men of this country, but it should be recorded that probably the first title he ever saw in print was "Orville Wright—Publisher."

A reproduction of part of the first page of one of these newspapers is shown on this page. It will be noticed that this was in 1889—14 years before the epoch-making flight at Kitty Hawk.

WEST SIDE NEWS

Vol. I. DAYTON, OHIO, MARCH 16, 1889. No. 2.

West Side News.

PUBLISHED WEEKLY.

Orville Wright - - - Publisher.

TERMS:—One year, forty cents. Ten weeks, ten cents.

DAYTON, OHIO.

Circumstantial Evidence.

Hon. O. H. Smith in his Reminiscences of Early Indiana Trials, relates the following:

Judge Eggleston said: "There is but one case on the docket for trial, an appeal case, damages claimed five dollars. I feel quite tired, and will be obliged to my associates to try the case." "Certainly," replied Judge Cushman.

The case was called. Henry Cooper was for the plaintiff, and Hiram Brown for the defendant. The case lated and extensively read by the courts and lawyers until the tendency of the courts was to reject circumstantial evidence. My friend, Mr. Brown, an ingenious attorney, of fine talents, and by the way, rather waggish, said: "A single question, Mr. Witness; can you swear you saw the bullet hit the dog?" "I can swear to no such thing." "That's all Mr. Cooper; a case of mere circumstantial evidence, your Honors.", Cooper's countenance fell; defeat stared him in the face; the case was submitted to the court without further evidence. Judge Cushman said: "This is a plain case of circumstantial evidence; judgment for the defendant."

Cooper, with great indignation, with his eyes on Brown, remarked: "When I die I wish

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N. W. Cor. Third and Williams.

Visit to Guggenheim Park

To allow members of the Institute and their guests to visit Guggenheim Park, special arrangements were made on June 4, 1944, to have the Manor House and grounds open for inspection. This date was chosen because the famed Rhododendron Drive was in bloom.

Over 100 members and guests availed themselves of the opportunity to make the visit and inspect the main house, grounds, and The Paul Kollsman Extension Library of over 3,000 books.

Gifts to the Aeronautical Archives

Orville Wright gave two issues of the *West Side News*, which he published in Dayton as a boy. The National Aviation Corporation gave 16,000 mounted and indexed clippings for the year 1938 through 1941, 600 aeronautical magazines, 500 annual reports of aviation companies, 48 volumes of *American Aviation Daily*, and 100 hearings of Congressional committees on appropriations. S. Paul Johnston sent 700 aeronautical photographs, a model of the U.S. Navy airship "Shenandoah," made from the metal of the airship and a model of a Henschel biplane. William B. Stout gave blueprints and catalogues of the Dornier-Werke in Friedrichshafen, adding to his previous gifts.

A colored print of the Lockheed transport airplane Constellation was received from the Hamilton Standard Propellers Division of United Aircraft Corporation. The Ecuadorian Air Force gave its breast and cap insignia. George S. Armstrong sent volumes 2, 3, and 4 of *An Engineering Interpretation of the Economic and Financial Aspects of American Industry* from his personal file.

Copies of the *S.B.A.C. Press Summary*, in addition to those previously given, were received from The Society of British Aircraft Constructors, through the courtesy of B. J. Hurren. The British Air Commission added 69 *Air Ministry Translations* to the large number previously given. The Globe Aircraft Corporation gave two copies of its *Readings on Post War Personal Aircraft*.

A framed print, "The Ninth Air Force Sweeps Down," was received from the Pratt & Whitney Aircraft Division of the United Aircraft Corporation. Airplane prints of the Mariner, Marauder, and the Mars, by Charles H. Hubbell, were given by The Glenn L. Martin Company. The Republic Aviation Corporation gave a model of the P-47 Thunderbolt. Dr. Alexander Klemin added books, clippings, and pamphlets to his previous gifts. Mrs. Bella C. Landauer added aeronautical playing cards to her previous generous gifts.

Badges and insignia were received from American Export Airlines, Inc.; The Cleveland Pneumatic Tool Company; Fairchild Aircraft, Ltd.; Firestone Tire & Rubber Company; Howard Aircraft Corporation; Jack & Heintz, Inc.; Otto Aviation Corporation; Pan American Airways System; Rohr Aircraft Corporation; and U. S. Propellers, Inc.

Among the donors of other gifts were the British Information Services, Eclipse-Pioneer Division of Bendix Aviation Corporation, Corrington Gill, Fairchild Engine & Airplane Corporation, Harvard School of Business Administration, New York State Departments of Commerce and Education, Gerrit Weston, U.S. Army Air Forces, David Taylor Model Basin, Library of Congress, Office of Defense Transportation, Office of War Information, Senate Library, and Congressional Committees on Appropriations, Naval Affairs, and Postwar Economic Policy and Planning.

R. G. Bartlett, (72) Frederic Flader, (73) R. T. Goodwin, (74) Lt. H. K. Hardy, (75) Lt. J. E. Arnoult, (76) Lt. Buckley, (77) Lt. N. Goodwin.

An Appreciation

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Listed below are the leading aeronautical and industrial companies that make possible the publication of the *Journal of the Aeronautical Sciences*.

They enable the Institute to publish scientific and technical papers in the *Journal* and to devote its pages exclusively to editorial material.

Dues from individual members which would normally be used to publish this scientific and engineering quarterly are thus released for additional services to the profession and industry.

Advertising defrays the cost of publishing the *Aeronautical Engineering Review* and the *Aeronautical Engineering Catalog*.

These publications provide a comprehensive technical information service for the benefit of the aircraft and related industries.

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Summer Annual Meeting

The Summer Annual Meeting of the Institute was held in the Hancock Auditorium of the University of Southern California in Los Angeles on the afternoons and evenings of July 27 and 28. Three hundred members and guests attended the Technical Sessions.

In order to allow sufficient time for discussion, each session was limited to a maximum of three papers. The complete program of the meeting follows. Abstracts of each of the papers presented have been included for the information of members and subscribers.

Each of the papers presented will be considered for publication in forthcoming issues of either the JOURNAL OF THE AERONAUTICAL SCIENCES or the AERONAUTICAL ENGINEERING REVIEW.

Individuals desiring copies of the papers should write directly to the authors, since all preprints made available by the authors to the Institute are reserved for the use of company libraries. Only one set of preprints will be made available to companies or their divisions at a mailing charge of $0.25 per preprint.

Program

Thursday, July 27, 1:00 P.M.

Chairman: Clark B. Millikan
California Institute of Technology

Cochairman: J. Richard Goldstein
Douglas Aircraft Company, Inc.

Measurement of Maneuvering Loads in Flight—C. J. Buzzetti and W. L. Howland, Lockheed Aircraft Corporation.

Large aircraft design has been impeded because of a lack of accurate knowledge of basic loads resulting from maneuvers. This paper describes flight-test measurements of engine mount and wing loads during rolls and tail and boom loads during pull-outs on a P-38 airplane; also some maneuvering loads measured on the Constellation are described. Wire strain gauges were used in making the measurements, and the instrumentation setup is described. Plots of control force versus time, with their resulting accelerations and loads are shown. Measured maneuvering tail loads on the P-38 during sudden pull-ups are shown to be small as compared to those used in design. The maneuvering load is shown to be more a function of the rate of application of control force than the acceleration obtained at the center of gravity. Flight measurements can definitely show what members in redundant structures become critical under maneuvering conditions as well as the magnitude of the applied loads. It is felt that structural measurements should be confined primarily to the measurement of basic loads rather than detail stress distributions.

The Thermodynamics of the Laminar Boundary Layer of a Heated Body in a High-Speed Gas Flow Field—Arthur N. Tifford, Lockheed Aircraft Corporation.

The thermal boundary-layer equations for a two-dimensional gas flow are treated in a manner similar to Falkner and Skan's general solution of the velocity boundary-layer equations. When the local velocity outside the boundary layer increases as a power of the distance along the surface, a particularly simple solution for the temperature field exists. This solution in combination with a new solution of the velocity boundary-layer equations, shows that an analogy exists between the *momentum loss* in the boundary layer and the rate of heat transfer, despite the presence of a pressure gradient. The analogy is applied to the calculation of the variation of the local heat transfer coefficient over the front half of a circular cylinder and fairly good agreement with experimental data shown.

A rather general differential equation defining the effect of the generation of heat in the boundary layer by friction and shockless compressibility is derived, and the results of some numerical integrations are presented. The effect of the internal generation of heat is shown to be simply equivalent to an increase in the temperature of the gas.

Thursday, July 27, 7:00 P.M.

Chairman: A. L. Klein
Douglas Aircraft Company, Inc.

Cochairman: E. C. Wells
Boeing Aircraft Company

Equilibrium of Nondevelopable Semimonocoque Structures with Longitudinal Members and Frames, Considered as Beams of Variable Section—Leon Beskin, Consolidated Vultee Aircraft Corporation.

The author develops analytical and graphic methods defining stresses in semimonocoque structures of arbitrary shape which fulfill all the conditions of local equilibrium when the distribution of axial loads at two ends is known. These end distributions can be defined either in function of applied loads, or approximately by a conventional beam distribution, or more correctly by methods of least work. The method is applied for both open and closed membranes.

The analysis comprises two parts: (a) study of the conditions of equilibrium of a skew panel limited by two members and two frames; (b) general equilibrium of the structure. The conditions of equilibrium of an isolated panel can be simply interpreted in terms of a graphic method, which, successively applied to all the panels of a structure, defines its complete equilibrium. The analysis shows that, generally, shears and normal stresses inside the structure cannot be determined by the beam theory, even if the latter is used to define end normal stresses, and that the difference cannot be accounted for by conventional corrections for shear obtained by consideration of the slopes of the members.

Influence Coefficients in Stress and Vibration Analysis—Robert Rosenbaum and Robert Scanlan, Eastern Aircraft Div., General Motors Corporation.

This paper presents a summary of known techniques. Its essential contribution is the presentation in concise form of powerful analytical tools that as yet do not appear widely spread among stress and vibration analysts in the aeronautical field.

The concept of influence coefficients is recalled. Techniques for deriving both bending and torsional influence coefficients for typical wing structures are introduced. In proceeding to the derivation of torsional influence coefficients a useful loading analysis is pointed out for two-spar plus torque box wings having cutouts, etc. A discussion of the so-called elastic axis of such structures is included.

Use is made of influence coefficients and the matrix iteration process to make uncoupled vibration frequency and mode analyses for first and higher modes of wings and fuselages. Velocities of aileron reversal and wing torsional divergence are also calculated by this process. Examples are given to illustrate techniques.

Friday, July 28, 1:00 P.M.

Chairman: Elliott G. Reid
Stanford University

Cochairman: E. J. Horkey
North American Aviation, Inc.

The Effective Use of Aerodynamic Balance on Control Surfaces—L. E. Root, Douglas Aircraft Company, Inc.

An analysis is made of basic wind-tunnel data on a control surface model constructed to obtain the effects of variation in movable control surface nose shape and amount of overhang, and design methods are presented leading toward the effective use of aerodynamic balance for control force reduction. Using theoretical parameters for simply hinged flaps as a basis, model hinge moment data are analyzed to obtain multiplicative factors that correct for variations in overhang and balance nose shape. Three-dimensional control surface parameters are developed for use in estimating control forces and effectiveness. The degree to which various nose shapes are subject to critical icing is shown from ice-tunnel tests, and the results are applied to the rudder designs of multiengined

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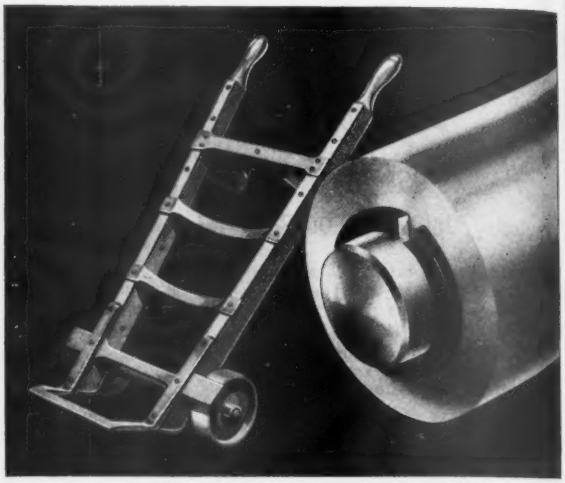

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airplanes making use of proportional overhang balance.

The relationship of design factors affecting the choice of elevator aerodynamic balance to variation in overhang and balance nose shape is shown. Application of these limits to the horizontal surfaces of three typical airplanes shows the basic difficulty of reducing elevator control forces to acceptable values, still maintaining adequate elevator control. Effect of Mach Number variation on the hinge moments and pressure distribution of a typical movable control surface with overhang is indicated. To illustrate the practical use of aerodynamic balance, representative control surface mean airfoil sections from the empennages of eight full scale airplanes are presented. Both the balance nose shape and amount of overhang are clearly shown as well as hinge location, limiting travel, gap, and modifications to the basic N.A.C.A. airfoil used. It is emphasized that proportionality of control surface plan form and section will contribute to the more effective use of aerodynamic balance in obtaining maximum control force reduction without sacrificing other desirable control characteristics.

Spring and Gravity Moments in the Control System of an Airplane—Reinhardt M. Rosenberg, Consolidated Vultee Aircraft Corporation.

Spring and gravity moments may be included in any one of the control systems of an airplane. However, they are most frequently employed in the longitudinal control system. Gravity moments, i.e., bob weights, may be used:

(a) To change the stick force gradient.
(b) To change the stability characteristics.
(c) To act as load factor limiters.

Spring moments may be used:

(a) To achieve an "equivalent" shift of the center of gravity in unaccelerated flight.
(b) To counterbalance gravity moments in unaccelerated flight.

The results of theoretical and flight-test analyses reported in the literature are summarized. In addition, it is shown that elevator flutter may develop because of a bob weight installation and that this tendency may be controlled at will by shifting the location of the bob weight along the fuselage span. Methods of vibration tests and theoretical considerations are discussed by means of which this type of flutter can be avoided. Finally, recommendations are made for the proper design of bob weight installations.

Friday, July 28, 7:00 P.M.

Chairman: E. G. Stout
Consolidated Vultee Aircraft Corporation

Cochairman: William R. Sears
Northrop Aircraft Corporation

Altitude Chamber Tests of Aircraft Electric Motors and Generators—Fred A. Heddleson, Westinghouse Electric and Manufacturing Company.

I. A. S.

National Meetings Schedule

1944–1945

October 20, 1944
AIR TRANSPORT MEETING — WASHINGTON, D.C.

November 9–10, 1944
FALL MEETING — DAYTON, OHIO

December 17, 1944
WRIGHT BROTHERS LECTURE — WASHINGTON, D.C.

January 30–31, February 1, 1945
THIRTEENTH ANNUAL MEETING — NEW YORK

April, 1945
SPRING MEETING — DETROIT, MICHIGAN

The Officers and Council of the Institute invite participation in the Technical Sessions of the Meetings of the Institute.

The Meetings Committee will consider for inclusion on the program complete papers, or outlines or summaries of proposed papers.

Information for Participants

(1) Complete papers, or outlines or summaries should be submitted in triplicate at least four months prior to the meeting at which it is proposed to present the paper. Outlines or summaries should not exceed 1,000 words.

(2) Each paper should be so planned that it may be presented within a time limit of 45 minutes.

(3) All papers submitted will be considered for publication in the **Journal of the Aeronautical Sciences** or the **Aeronautical Engineering Review.** While a paper should be planned to take only 45 minutes for presentation at a meeting, the written presentation may have a maximum length of approximately 15,000 words.

(4) All material received will be submitted to the Meetings Committee. Authors will be notified, in ample time to prepare the complete paper, whether or not their papers can be scheduled for presentation.

All correspondence should be addressed to
The Meetings Committee
Institute of the Aeronautical Sciences
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30 Rockefeller Plaza
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Actual conditions of flight at high altitudes are of such great importance that, unless accurate duplication is secured, the results of chamber tests probably will not agree reasonably with flight-test results.

Temperature, pressure, and humidity in the stratosphere are discussed, and it is pointed out that the extremely low humidity is the most important single factor causing the rapid brush wear on electrical machines at high altitudes.

Altitude chambers are discussed briefly and the essential features of the Westinghouse chamber are explained to show their functional use in testing aircraft electric motors and generators.

The preparation of equipment for tests and the method of testing are outlined; it is stressed that careful preparation of the equipment is equally important with the accurate duplication of altitude conditions. It is recommended that more use be made of the term "density-altitude" and that density of the air, rather than its pressure, be reproduced in the altitude chamber.

Lag Determination of Altimeter Systems—R. M. Head, Lockheed Aircraft Corporation.

With the advent of present-day high rates of climb and diving speeds, an accurate knowledge of the lag in the altimeter system is essential to the determination of true air speed, Mach Number, etc. A theoretical analysis of the response of the altimeter when a step function is applied is given and checked with corresponding experimental data. The theoretical analysis is extended and equations developed for determining the pressure-altitude at the static head from the indicated reading of the altimeter. These equations contain constants which are a function of the particular altimeter system involved, and a simple method for experimentally determining them is given. Using these final equations with the predetermined constants, a set of curves is developed for a particular airplane whereby the correction to be applied to the altimeter is obtained directly from a knowledge of the indicated altitude and the rate of change of altitude at that point.

The Use of a Precision Automatic Pilot in Recording Aircraft Performance Data—Robert J. Kutzler, Minneapolis-Honeywell Regulator Company.

Development of aircraft design for improved performance can be accelerated if the flying characteristics, studied by flight testing, are quantitatively recorded with a degree of accuracy comparable to that of wind-tunnel test measurements. Present flight-performance tests depend largely upon pilot impressions and limited instrumentation for a qualitative expression of flying characteristics. Because of the limited instrumentation, the test pilot's skill and aerodynamic background are major functions of aircraft performance data. It is relatively difficult to translate pilot impressions into quantitative design criteria.

The gyro stabilizers of a precision automatic pilot control the aircraft with a greater degree of accuracy than is possible by the human pilot. This should improve the quality of power-plant and propeller calibration tests, as well as increase the accuracy of aerodynamic data.

In addition to providing accurate control, the automatic pilot provides a stable reference against which the aircraft attitude, angle of attack, rate of control, control sensitivity, control force, and stability may be simultaneously and accurately recorded for all three axes.

It is suggested that personnel interested in obtaining accurate performance data investigate the use of an automatic pilot.

Actual flight test data for several specific problems are presented to illustrate some advantages of using an instrumented automatic pilot when determining aircraft performance.

New Corporate Members

The following are brief summaries of the products and activities of companies that have recently become corporate members of the Institute.

The Cleveland Graphite Bronze Company is one of the largest manufacturers of lined-sleeve bearings and bushings in the world. Although the company makes bearings and bushings for all types internal-combustion engines and many other uses, its activities during the war have been largely in copper-lead and silver aircraft bearings.

It has been credited with numerous technical developments and has constantly striven to achieve improvements in the quality of bearings for aircraft radial air-cooled engines. Many of the most recent advances are not available for publication at this time for military reasons, but it can be stated that the company has given great impetus to technical improvements in bearings.

Experimental bearings for the newest types of engines are a major part of the company's activities.

Micromatic Hone Corporation has cooperated, since about 1930, with manufacturers of aeronautical engines and other products in the development of hone-abrading processing. The processes are employed to obtain the maximum safety of highly stressed operating parts with the most favorable power-to-weight ratio. Today, many such surfaces and parts in aircraft engines are finished to desired accuracies, sizes, and various degrees of smoothness by the hone-abrading process.

The company assisted in the development of tooling and methods, first for finishing and, second, for generating choked bores in aircraft-engine cylinders. In cooperation with the Air Service Command, it has developed tooling and procedure for reconditioning aircraft engines at various Air Depots throughout the United States and abroad.

The organization has worked closely with the porous chrome-plating development for aircraft-engine cylinder bores and piston rings and has developed tools and methods for the practical production processing of hard material.

National Credit Office, Inc., specializes in information about concerns identified with the aeronautical industry.

A survey is published each month listing and classifying manufacturers of aircraft, aircraft engines, parts instruments, and accessories; air service operators; and distributors of aircraft products. Special reports are published periodically regarding individual concerns.

Discussion meetings are conducted at regular intervals in New York, Cleveland, and Chicago. These meetings are attended by representatives of the principal suppliers of materials, parts, accessories, and equipment.

The service is used by suppliers to the aeronautical industry as a source of information not only for specific accounts but, in addition, for information about important industry problems such as termination, financing procedures, renegotiation, surplus disposal, contractor relationships, and similar subjects.

Victor Adding Machine Company's Research Laboratory is engaged in the development of various types of aircraft instruments, particularly gyroscopically controlled and indicating instruments. Research is also being carried on in cooperation with the Army Air Forces for the development of various types of sighting instruments used in airplanes.

The laboratory is presently located in Evanston, Ill. A specially designed research building is being constructed and will be ready for occupancy the early part of 1945.

Sections and Branches

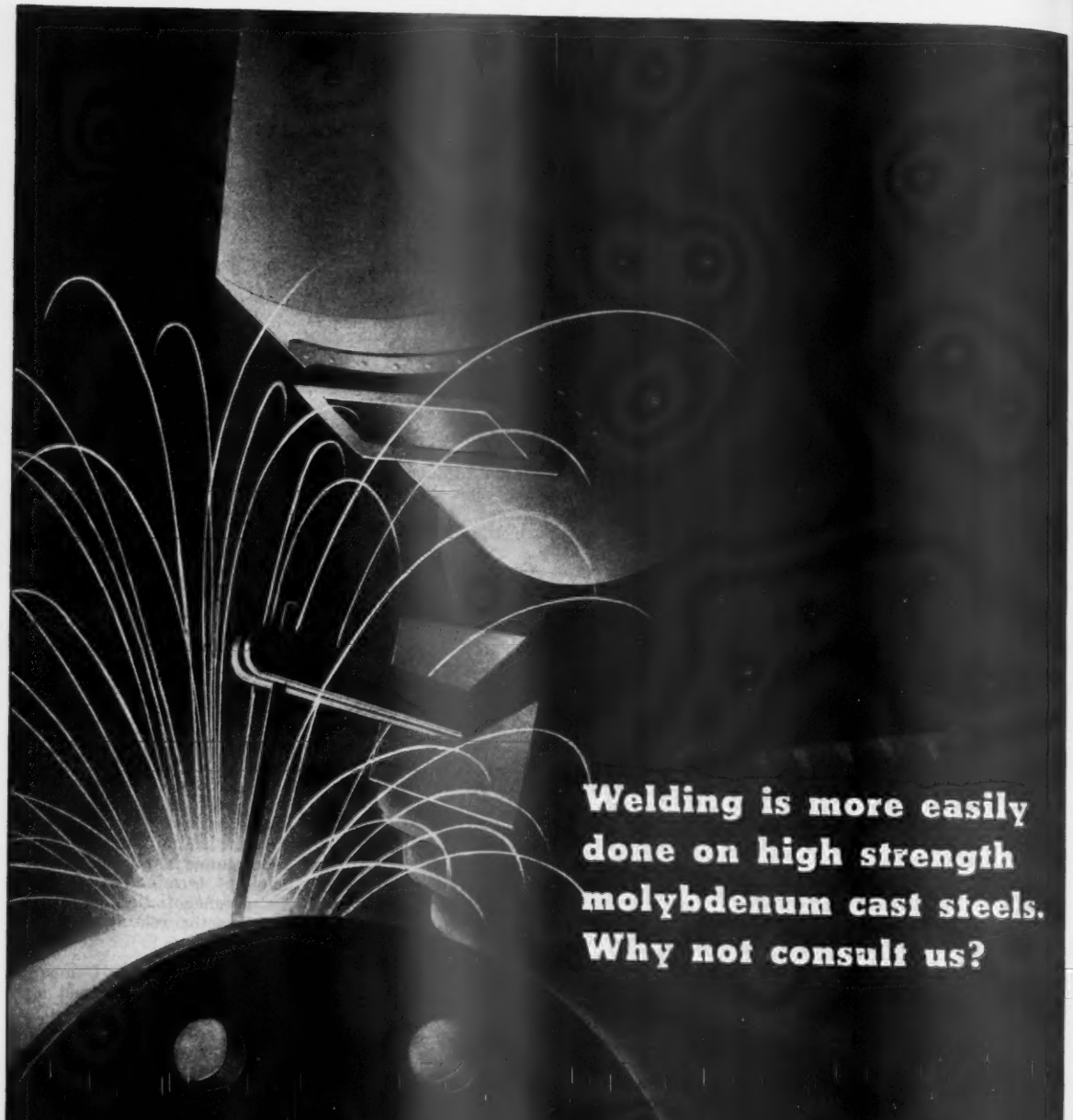
Cleveland Section

The Cleveland Section held a meeting on June 21 at the Case School of Applied Sciences. A short business session was followed by a talk on air-line operation and equipment, by M. B. Crawford, Chief Equipment Engineer of United Air Lines.

New York Section

A technical meeting was held by the New York Section on June 8 in the auditorium of the McGraw-Hill Building. Frederick K. Teichmann, Chairman, presided.

A talk was given by Rowland Burnstan, President and General Manager of



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Lawrance Aeronautical Corporation, on the "Design and Installation of Auxiliary Power Plants."

Jerome Lederer of Aviation Insurance Underwriters showed a short motion-picture film portraying the instrument board of an airplane during a test flight that ended in a fatal accident.

San Diego Section

The June dinner meeting of the San Diego Section was held on Friday, June 9, at the San Diego Women's Club. The speaker of the evening was William B. Stout, of the Stout Research Laboratories of Consolidated Vultee Aircraft Corporation. He spoke on "Aviation and the Postwar Car" and gave the highlights relating to the past and present developments of the automobile, as well as the trend that the future automobile will take as a roadable airplane. Mr. Stout also spoke about his ideas concerning the kind of "push-button" world in which we will live after the war, and he answered a wide variety of questions relating to postwar developments.

It was announced by Chairman E. G. Stout that the next meeting on August 18 would be a dinner meeting, at which Major Knox Manning was to be the speaker.

Illinois Institute of Technology

At a meeting on June 2, M. J. Leonard, Superintendent of the Engine Testing Laboratory at the Chicago plant of Douglas Aircraft Company, Inc., spoke about the testing of an aircraft engine. He traced all of the steps in this process from the time of final assembly on the production line until the engine is crated on the shipping floor. He also described several parts of the engine which had previously been unfamiliar to the members.

The final meeting of the current semester was held on June 16 at which the following officers for the coming semester were elected: Chairman, Milton Schwartz; Vice-Chairman, Art Rynkas; Treasurer and Secretary pro tem, Sidney Mayster.

Casey Jones School of Aeronautics

Warren Reider was elected Treasurer of the Branch and succeeds Lloyd Goldberg, who resigned from his post to enter the Navy.

A semiannual dance was held in the Cafe Rouge of the Hotel Pennsylvania, New York, on June 24.

Stanford University

Activities of the Stanford University Student Branch for the Spring Quarter consisted of three meetings.

A meeting on April 26 was featured by talks on helicopters by two student members, Thomas Kirkwood and Henry Ponsford. The meeting of May 24 also included talks by two student members, Adrien Anderson and Richard Heppe, on "Modern British and German Military Aircraft." This talk was illustrated by motion pictures of modern aerial warfare.

At a meeting on June 14, a lecture was given by H. J. Allen, of the N.A.C.A., on the nature of compressibility and its effects on aircraft design. This meeting concluded the activities of the Stanford Student Branch for the school year 1943–1944.

News of Members

Frank E. Buckell has been appointed Manager of the new Aeronautical Department of General Electric Company, Ltd., in England.

V. Cadambe has been placed in charge of flutter and vibration analysis in the Engineering Department of Interstate Engineering & Aircraft Company.

Julius Cesarini has joined Eastern Aircraft Division of General Motors Corporation as Design Engineer.

George H. Compter has been appointed Staff Engineer in the Aeronautics Division of the Society of Automotive Engineers.

George G. Cudhea, formerly Assistant Chief Engineer, has been made Chief Engineer of the Fleetwings Division of Kaiser Cargo, Inc.

Nicholas J. den Tex has been advanced to the position of Installation Requirements Engineer of the Pratt & Whitney Aircraft Division of United Aircraft Corporation.

John C. Dykes has been transferred to Division No. 4 (South Africa) of British Overseas Airways Corporation as Technical Officer for Empire Flying Boats.

Frederic Flader, formerly Chief Engineer of the Buffalo Plant of the Airplane Division of Curtiss-Wright Corporation, has organized and been elected President of the Frederic Flader Company.

George G. Geelan has received his commission as an Ensign in the U.S. Navy.

Myron B. Gordon has resigned as Vice-President and General Manager of Wright Aeronautical Corporation but has not yet announced his future plans.

Louis F. Hummel has joined the New Departure Division of General Motors Corporation as Sales Coordinator.

Charles E. Kahlke, Jr., has entered the employ of the Stevens Institute of Technology as Design Engineer working in connection with the Experimental Towing Tank.

Harvey A. Leich has been promoted to the rank of Major and assigned as Unit Engineering Officer in the U.S. Marine Corps.

Albert L. MacClain, Chief Test Pilot and Aeronautical Engineer at the Pratt & Whitney Aircraft Division of United Aircraft Corporation, has been advanced to the position of Liaison Engineer and will aid in the solution of installation engineering and operational problems.

Gustaw A. Mohyla-Mokrzycki, formerly Professor of Aeronautics and Head of the Aeronautics Department of the Polytechnic College of the University of Montreal, has joined Consolidated Vultee Aircraft Corporation as Research Engineer.

John A. Nicas has been appointed Handbook Group Leader at Boeing Aircraft of Canada.

Abram B. Nierenberg has entered the service of Republic Aviation Corporation as Layout Draftsman.

Robert M. Shack has been appointed to the Staff of the National Advisory Committee for Aeronautics as Aeronautical Engineer at the Langley Memorial Aeronautical Laboratory.

G. Stirling Thompson has been promoted to Assistant Chief Engineer in the Fleetwings Division of Kaiser Cargo, Inc.

Sir Henry Thomas Tizard, President of Magdalen College, Oxford, England, has been selected for the award of this year's Albert Gold Medal by the Royal Society of Arts for his work in aeronautical research. During the first year of the war he had complete charge of research and development for the Royal Air Force, later going to the Ministry of Aircraft Production, and in 1941 was appointed to the Air Council.

George H. Tweney has become Director of the Aeronautical Engineering Department of the University of Detroit.

George M. Williams, Jr., Senior Vice-President and Director of Curtiss-Wright Corporation, has been elected to the additional office of Executive Vice-President of Wright Aeronautical Corporation.

Richard S. Williams has joined the Latin-American Division of the Pan American Airways System in Puerto Rico.

James F. Woodall has been transferred to the Consairway Division of Consolidated Vultee Aircraft Corporation as Operations Engineer.

Raymond A. Young has joined Kellett Aircraft Corporation, Plant No. 2, as Design Test Engineer.

Members Elected

The following applicants for membership or applicants for change of previous grade have been admitted to membership in the grades indicated since the publication of the list in the last issue of the REVIEW.

Transferred to Associate Fellow Grade

Chapleo, Charles, Chief Structures Engineer, Airspeed, Ltd.

Gilchrist, Gibb, Dr.Sc. (Hon.); President, Agricultural and Mechanical College of Texas.

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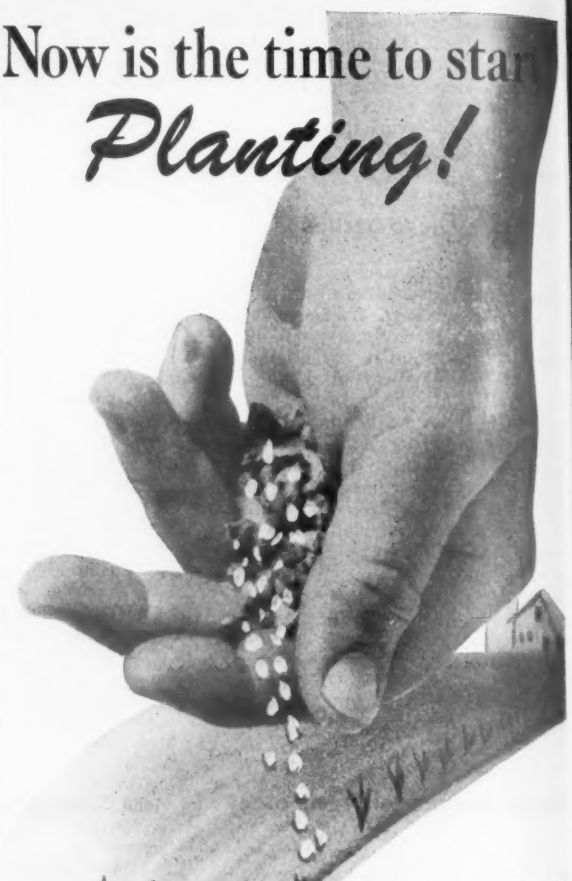

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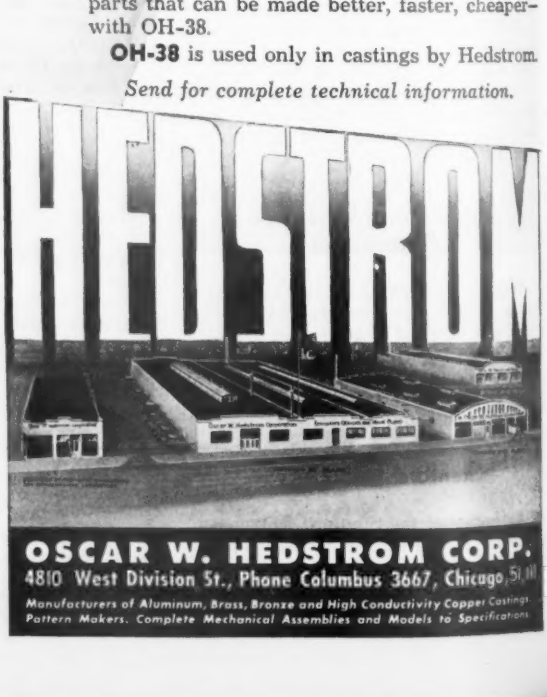

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Hanks, Stedman Shumway, Col., B.A.; Acting Trustee, American Flight-Strips Assn.

Elected to MEMBER Grade

Amneus, Thomas Axel, B.S. in C.E.; Sr. Stress Analyst, Hughes Aircraft Co.

De Haven, Hugh, Research Associate, Dept. of Physiology, Cornell University Medical College.

Dobbins, Robert N., B.S. in M.E.; Commanding Officer, U.S. Naval Auxiliary Air Station.

Friend, Carl Frederick, B.S. in Ae.; Research Engineer (Aerodynamics), Lockheed Aircraft Corp.

Gooch, Peter William, M.A.Sc.; Chief Engineer, Aircraft Div., Canadian Vickers Ltd.

Heintze, Carl Paul, Design Engineer, Sikorsky Aircraft Div., United Aircraft Corp.

Herman, Kenneth R., Vice-President, Chief Engineer, Manager, Vickers, Inc.

Hyatt, Abraham, First Lt., U.S. Marine Corps, in charge of Design Research Section of the Aviation Design Research Branch, Bureau of Aeronautics.

Jonah, Frederick Chapman, Ph.D.; Analytic Project Engineer Chance Vought Aircraft Div., United Aircraft Corp.

Juhola, Martin John, Major Layout Draftsman, Pratt, Read & Co., Inc.

Lundquist, Elmer Clinton, M.S. in M.E.; Asst. Prof. in Aeronautics, State University of Iowa.

Pardy, George William, Col., Chief, Training Aids Div., Headquarters, U.S. Army Air Forces.

Payne, Vernon William, Engineering Dept., Robertson Aircraft Co.

Pecker, Joseph Samuel, Owner, Machine & Tool Designing Co. of N.Y., and Chairman of the Board, RotaWings, Inc.

Ricklefs, James Seymour, B.S. in Ae.E.; Sr. Stress Analyst, General Airborne Transport Co.

Roberts, Henry Wilde, free-lance writer.

Schaeffer, Emile Joseph, Assoc. Aero. Engineer, Bureau of Aeronautics Rep. Office (Navy Dept.), Consolidated Vultee Aircraft Corp.

Sheng, James, B.S.; Capt., Chinese Air Force, Commission on Aeronautical Affairs of China.

Smith, Lee Harvey, General Manager, Fairchild Aircraft Div., Fairchild Engine & Airplane Corp.

Starzyk, Michael Lawrence, Chief, Technical Data Section, Engineering Dept., Sikorsky Aircraft Div., United Aircraft Corp.

Thurman, Arvo August, Chief Draftsman in charge of Design, Gould Aero. Div., Pratt, Read & Co., Inc.

Vielle, Eugene Emile, Wing Commander, Royal Air Force; Chief of Navigation & Instrument Branch, British Air Commission.

Wallace, Leland S., B.S. in M.E.; Development Engineer, Central Aircraft Corp.

Wasielewski, Eugene Walter, M.S.; Chief Engineer, B-W Superchargers, Inc.

Weinfurt, William James, B.S. in M.E.; Group Engineer—Controls, Sikorsky Aircraft Div., United Aircraft Corp.

Westman, Harold Prendergast, Asst. to Major Gardner, Institute of the Aeronautical Sciences, Inc.

Yamaguchi, Frank Masataka, Hydraulic Engineer, Curtiss-Wright Corp.

Transferred to MEMBER Grade

Cary, Charles Oswald, Executive Asst. to the Chairman, C.A.B.

Schetzer, Julius David, M.S. in Ae.E.; Structures Engineer, Stinson Div., Consolidated Vultee Aircraft Corp.

Elected to Industrial Member Grade

Fruauff, George Louis, Jr., Final Inspector, Eastern Aircraft (Linden Div.), General Motors Corp.

Haines, Robert Loel, Supervisor, Blueprint Control Dept., Rohr Aircraft Corp.

Jump, Norman, Supervisor—Tool & Operation Planning, Consolidated Vultee Aircraft Corp.

Peck, Arthur Knowlton, Asst. to the President, Republic Aviation Corp.

Rianhard, James Lincoln, Sales Engineer, Aviation Sales Dept., Standard Oil Co. of N.J.

Zint, William, Technician, Longines-Wittnauer Watch Co., Inc.

Elected to Technical Member Grade

Aschen, Raymond Holiday Owen, Hydraulic Engineer, The Emerson Electric Mfg. Co.

Beffa, Richard Howard, Ens., Flight Operations Officer, Navy Air Force, U.S.N.R.

Brown, Terrill Owen, Research & Design Engineer, Aircraft Mechanics Inc.

Clegern, William Argyle, B.S. in M.E.; Design Engineer, Consolidated Vultee Aircraft Corp.

Davis, Jefferson Deveaux, Jr., M.S. in C.E.; Vibration Engineer, Bell Aircraft Corp.

Dina, Salvatore Bernard, Asst. Group Engineer, Consolidated Vultee Aircraft Corp.

Farrar, Nadim, B.S. in C.E.; Design & Weights Engineer, Rohr Aircraft Corp.

Hollo, Ben F., Lead Engineer, Boeing Aircraft Co.

Horning, Don Oury, B.A.; Research Test Engineer, Consolidated Vultee Aircraft Corp.

Kavanagh, Thomas Christian, M.S. in C.E.; Structural Engineer, Fairchild Aircraft Div., Fairchild Engine & Airplane Corp.

Kinnavy, Martin Gerald, B.Sc. in M.E.; Stress Analyst (Airplane), Fisher Body Div., General Motors Corp.

Pierce, Hugh Otis, Service Engineer, Lockheed Aircraft Corp.

Russo, John William, Layout Engineer, Chance Vought Aircraft Div., United Aircraft Corp.

Stein, Hyman, B. of Ae.E.; Asst. Ballistician, Exterior Ballistic Branch, Ballistics Research Lab.

Stephenson, Thor E., B.A.Sc.; Jr. Research Engineer, National Research Council.

Stubau, Carl John, B.S. in M.E.; Project Engineer, Pesco Products Co., Div. of Borg-Warner Corp.

Terranova, Nicholas Joseph, Salvage Engineer "A," Higgins Aircraft, Inc.

Transferred from Student to Technical Member

Barrington, William Norman, Jr., B.A. in Aero. Admin.

Bogart, Arnold David, 2nd Lt., B.S.; Engineering Officer (B24), U.S. Army Air Forces.

Burton, Donald Williamson, B.S.; Aero. Engineer P-1, Langley Mem. Aero. Lab., N.A.C.A.

Chappell, David Paul.

Comisarow, Paul, B.S. in A.E.; Aero. Engineer P-1, Langley Mem. Aero. Lab., N.A.C.A.

Dor, Frank Shing.

Flowers, Langdon Strong, B.S. in A.E.; Ensign, U.S.N.R.—A-V(S).

Franz, Edward Dietrick, Ens. A(V)S, U.S. Navy.

Gardner, John Joseph, B.A.E.; Jr. Aero. Engineer, Langley Mem. Aero. Lab., N.A.C.A.

Gault, Donald Eiker, B.S. in A.E.

Graham, George Gordon, B.S. in A.E.; to be inducted in the U.S. Armed Forces.

Hebert, John O'Niel, Jr., 2nd Lt., U.S. Army Air Forces.

Heller, Jack, B.S. in A.E.; Research, Polytechnic Institute of Brooklyn.

Johnson, Alan Dillistin, B.S. in M.E.; Aero. Engineer, Aircraft Engine Research Lab., N.A.C.A.

Leedy, James Donald, B.S. in A.E.; Aerodynamist, Consolidated Vultee Aircraft Corp.

Margosian, John Walter, B.E.E.; Research Associate, Aero. Dept., Polytechnic Institute of Brooklyn.

Marshall, Andrew Carter, B.S.; Ens., U.S. Navy.

Negrin, Romulo Mujailov, B.S. in A.E.; Sub. Lt., Aero. Engineer, Mexican Air Force.

Neyland, Charles E., B.S. in M.E.; Asst. Engineer, Lockheed Aircraft Corp.

Papas, Gus Samuel, B.S.; Douglas Aircraft Co., Inc.

Reed, Richard James, Jr., B.S. in M.E.; Ens., D-V(S), U.S. Navy.

Robinson, Robert Frank, B.S. in M.E.; Student, Case School of Applied Science.

G. Rodriguez, Luis Benito, B.S. in A.E.; Apprentice Engineer, AVIANCA.

Ryan, James Daniel, B.S. in M.E.; Student (V-12), U.S.N.R.

Shaw, Howard Albert, B.S. in A.E.

Suozzi, Frank Louis, B.S. in A.E.; Aero. Engineer, Aircraft Engine Research Lab., N.A.C.A.

Virgile, Lucien Gustav, B.S. in A.E.

Zeck, Richard Charles, B.S. in A.E.

Elected to Affiliate Grade

Carroll, Eleanor Elizabeth, B.A.; Jr. Aerodynamicist, Curtiss-Wright Corp.

Clay, Albert George, B.F.A.; Asst. to the Executive Engineer, Fairchild Aircraft Div., Fairchild Engine & Airplane Corp.

Davidson, Gordon Ingram, Tool Designer, Commonwealth Aircraft Corp.

Glass, Irving, Corporal, U.S. Army Air Forces.

Kreiser, Robert Jess, Draftsman-Engineer, Boeing Aircraft Co.

Wells, Viola May, Group Leader, Engineering, Fleet Aircraft Ltd.

Necrology

Major Perry J. Ritchie

Major Perry J. Ritchie lost his life while testing a B-25 bomber for the Army Air Forces at Los Angeles on April 24.

Major Ritchie was born July 11, 1915, in Dayton, O., and was graduated from the University of Cincinnati in June, 1939, with the degree of Aeronautical Engineer. During his term at college he was also engaged in work of an experimental nature at Wright Field, dealing largely with propeller design, vibration, flutter prevention, and flight testing. After graduation, he was commissioned and was advanced to the rank of Major in February, 1944.

Major Roy Edward Warren

Major Roy Edward Warren was reported to have been killed in action on March 22, 1944. He was serving with a bomber command in the Pacific at the time of his death.

Major Warren was a native of Albertville, Ala., where he was born July 21, 1914. He was graduated from Louisiana State University with the degree of Bachelor of Science in Aeronautical Engineering in June, 1936. He was commissioned as a Lieutenant in the Army Air Forces and served at different bases of the Air Forces in the United States before going overseas.

Personnel Opportunities

This column is for the use of individual members of the Institute seeking new connections and organizations offering employment to aeronautical specialists. Any member or organization may have requirements listed without charge by writing to the Secretary of the Institute.

WANTED

Graduate Mechanical-Electrical Engineers and Stress Analysts—Excellent immediate and postwar opportunity for qualified engineers having experience on small electromechanical devices. Apply by letter only giving experience and training résumé and draft status. Must comply with W.M.C. Regulations. Address inquiries to Lear Inc., Piqua, Ohio, R. J. Biggs, Special Representative.

Stress Analysts—at least two years' experience on aircraft stress analysis for similar work on plastic aircraft assemblies involving nonwrinkling skin construction. Address inquiries giving education, experience in detail, draft status and salary requirements to Universal Moulded Products Corporation, Bristol, Virginia, Attention Dr. R. J. Nebesar.

Aeronautical Engineer—A graduate engineer, specialized in performance and range studies, who is currently up to date with latest developments in flaps, slots, and high lift devices. Position for future development. All inquiries treated confidentially. Applicant must offer a statement of availability. Submit résumé of education, experience and salary requirements to the Development Division, Fairchild Engine and Airplane Corporation, 30 Rockefeller Plaza, New York 20, N.Y.

Aeronautical Engineer—with at least three years' experience on aircraft stress analysis for stress analysis and special project work in the development of aircraft and associated products. Write, advising experience in detail, draft status, and salary requirements. Address inquiries to Vidal Research Corporation, Central Airport, Camden, N.J.

Aircraft Engineers—openings available in progressive Aircraft Company for layout and design engineers to cover Wing, Empennage, Power Plant, Fuselage, Electrical and Radio, Landing Gear, Hydraulics, Equipment, and Controls. Also openings for Tool Designers, Tool Planners, Production Planners, Loftsmen and Aircraft Drawing, and Template Checkers. Those presently employed in essential war work need not apply. Airmail complete detail information regarding education, experience, salaries, former employers, age, family status, citizenship, and draft status, in order that we may be able to evaluate your qualifications from the first letter. Address inquiries Higgins Aircraft Inc., P.O. Box 32, New Orleans 6, La.

Product Designers & Draftsmen—Work on small electromechanical, aeronautical devices. Excellent postwar prospects. Must comply with W.M.C. Address reply to Lear Inc., Piqua, O., Att: R. J. Biggs.

Graduate Engineer for essential war work, opportunity for advancement and increased earnings. Aeronautical experience not necessary. Must be citizen, not employed in essential war industry, or have certificate of availability from the U.S. Employment Service Office or War Manpower Commission of your area. Write, direct, stating school, age, degree, experience, draft classification, and marital status to Consolidated Vultee Aircraft Corporation, Industrial Training Division, San Diego, Calif.

Aeronautical Engineer wanted for promotional work in expanding line of highly specialized equipment for aircraft, also airway and airport control tower equipment. Must have extensive background in aircraft instrumentation, know the pilot's problems and the requirements of the air lines. Good basic knowledge in aerodynamics, physics and electronics necessary. Engineering sales and service experience contacting air lines and aircraft manufacturers desirable. Apply Wallace & Tiernan Products, Inc., Belleville 9, N.J.

Aeronautical Engineers urgently needed by Consolidated Vultee Aircraft Corporation, Fort Worth Division, to execute program of extensive development of large aircraft. Applicant must have technical training and not presently employed in essential war industries. Apply direct to 921 Lamar Street, Fort Worth, Tex.

Industrial Engineers—major coast-to-coast air line, strong background accounting systems, operating cost accounting and capital items depreciation; must be willing to leave city. Permanent position offering unlimited opportunity. Describe background in detail. Enclose photo. Address inquiries to Box 240, Institute of the Aeronautical Sciences.

Engineers, Industrial for major coast-to-coast air line with procedural operating analytical experience, also comprehensive knowledge of the flow and control of forms and paper work. Must be willing to leave city—a permanent position, which offers unusual opportunity. Describe background fully. Enclose photo. Address inquiries to Box 239, Institute of the Aeronautical Sciences.

Aeronautical Engineer—A graduate engineer for work in a postwar development division. Past experience should include performance studies, project design, including engine installations, and some operational knowledge. Broad acquaintance in air lines and manufacturing industry would be an asset. Only those who can secure a release will be considered. Give full résumé, references, and salary requirements. Address inquiries to Box 238, Institute of the Aeronautical Sciences.

Helicopter Project Engineer—No helicopter experience required. Must have extensive record in the successful project management of Army-Navy airplane projects and certificate of availability. Pennsylvania aircraft manufacturer. Address inquiries to Box 235, Institute of the Aeronautical Sciences.

Aeronautical Engineers—needed by manufacturer of aircraft and aircraft parts in Minneapolis, Minn. Opening available for stress engineer, weight engineer and draftsmen. Applicants must have technical training, experience in the design of metal monocoque aircraft construction, must be draft exempt. Complete information as to education, experience, and salary ex-

pected should accompany first letter. Address inquiries to Box 234, Institute of the Aeronautical Sciences.

Senior Mechanical Engineers, Junior Mechanical Engineers, Mechanical Draftsmen needed for new aircraft engine programs by an aircraft-engine company in the eastern area. Aircraft-engine experience preferred but not necessary if mechanical background is satisfactory. Proper clearance with the War Manpower Commission necessary. To arrange for an interview, please send your qualifications to Box 232, Institute of the Aeronautical Sciences.

Engineers—design, aeronautical experience necessary; particular reference to work in hydraulics and structural design; also engineering draftsmen with aeronautical background. Address inquiries to Box 228, Institute of the Aeronautical Sciences.

Draftsmen—Detailers—Checkers—Stress Analysts, wanted by one of the larger aircraft accessories manufacturers. Excellent immediate and postwar opportunities. Plants located in southwestern Ohio. Address inquiries to Box 219, Institute of the Aeronautical Sciences.

AVAILABLE

Inspector and Production Engineer—5 years' experience in high-altitude fighter planes, desires employment with transport air line having postwar future. B.S. degree; linguist; any location. Address inquiries to Box 237, Institute of the Aeronautical Sciences.

Graduate Engineer, 5 years' experience, varied, in production control, planning, cost estimating and control, tooling, engineering, weights, and aerodynamics. Permanently draft deferred, single, release available, present salary $7,000 per year. Considerable experience in writing and preparation of technical reports, specifications, and proposals. Wants responsible position, permanent, in production or engineering with reputable firm, preferably in East but will travel if necessary. Address inquiries to Box 236, Institute of the Aeronautical Sciences.

Director of Quality, Chief Inspector for aircraft construction contact with Army or Navy (Navy preferred), 20 years' aircraft experience, also interested in aircraft maintenance, overhaul, and repair. Address inquiries to Box 230, Institute of the Aeronautical Sciences.

Structural Aeronautical Engineer—20 years in responsible positions as project, liaison, and development engineer on military and commercial aircraft. Desires similar air cargo or definite eastern postwar connection. Address inquiries to Box 217, Institute of the Aeronautical Sciences.

Consultant Aeronautical Engineer honorably discharged Army Air Forces, formerly executive Chief Engineer, desires additional consultant work, postwar. Address inquiries to Box 205, Institute of the Aeronautical Sciences.

(*Continued from page 128*)

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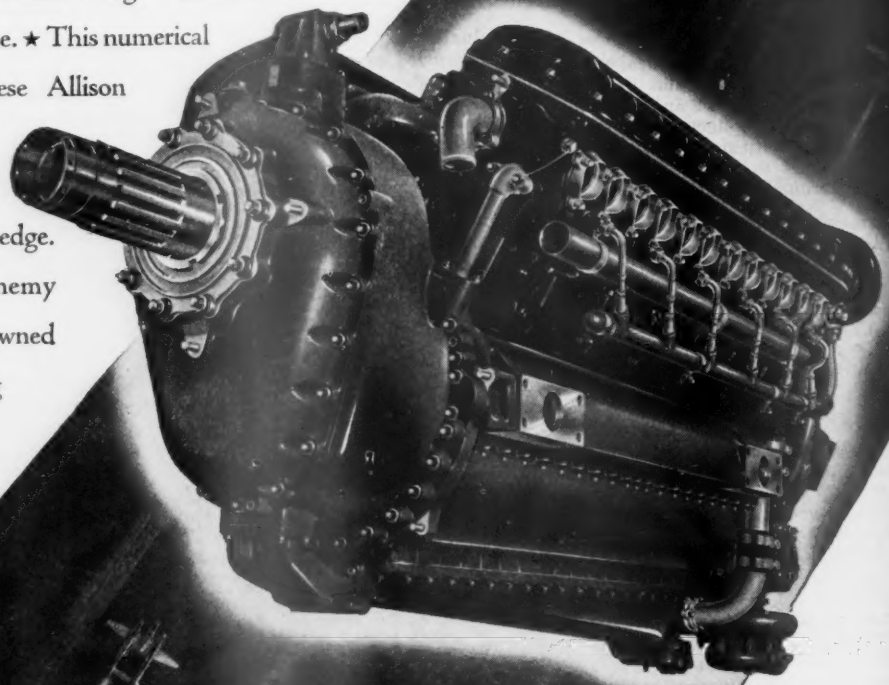

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